Australasian Plant Conservation

BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION Inc

VOLUME 21 NUMBER 4 • MARCH – MAY 2013

The future of Australia's flora: a policy perspective
Alpine seed and seedling ecology reveals important implications for management
Doing what's best for ecological communities - protection under national environment law
Building a South Australian database of biological life histories and disturbance responses
21 years of seed conservation in the WA Department of Environment and Conservation
Enhancing and restoring diverse grasslands and grassy woodlands: are we there yet?
And much much more …

CONFERENCE EDITION #2
PLANT CONSERVATION IN AUSTRALIA: ACHIEVEMENTS AND FUTURE DIRECTIONS

ANPC National Office

GPO Box 1777
Canberra, ACT 2601, Australia
Ph: (02) 6250 9509
Fax: (02) 6250 9528
Email: anpc@anpc.asn.au
Web: http://www.anpc.asn.au

National Office Staff

Tricia Hogbin and Merryl Bradley

Volunteer

Liz Myszka

ANPC Committee

President	Vice President
David Coates	Paul Gibson-Roy
Treasurer	**Secretary**
Adrian Fethers	Zoë Smith

Committee Members

Paul Adam, Doug Bickerton, Anne Cochrane, Phil Collier, Paul Donatiu, Sally Jacka, Helena Mills, Noushka Reiter, Mark Richardson, David Taylor.

ANPC News

To subscribe or unsubscribe go to http://anpcnews.blogspot.com/. To post a message, send a request to anpc@anpc.asn.au.

Australasian Plant Conservation

Editor

Selga Harrington

Editorial Team

Merryl Bradley, Paul Donatiu, Sally Jacka, Liz Myszka and Noushka Reiter

Layout & Graphic Design

Siobhan Duffy

Australasian Plant Conservation is produced by the ANPC Inc. with assistance from the Australian National Botanic Gardens.

Australasian Plant Conservation is printed on recycled paper.
ISSN 1039-6500

New Zealand Plant Conservation Network

President Philippa Crisp
Secretary John Sawyer
PO Box 5086 Wellington, New Zealand.
Email: info@nzpcn.org.nz
Web: www.nzpcn.org.nz

ANPC Major Sponsors

GOLD SPONSORS

AUSTRALIAN NATIONAL BOTANIC GARDENS

OTHER SPONSORS

Bjarne K Dahl Trust

NSW GOVERNMENT | NSW Environmental TRUST

Centre for Australian National Biodiversity Research

AlburyCity
Albury Botanic Gardens

NATIONAL ARBORETUM CANBERRA

Friends of the Australian National Botanic Gardens

TransGrid

ANPC Inc.
Mission Statement

"To promote and improve plant conservation"

Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. **The deadline for the June –August 2013 issue is Friday 13 May 2013.** The theme for the issue will be *fire and threatened flora*. General articles are also very welcome. Please contact Selga Harrington if you are intending to submit an article: selga.harrington@gmail.com

Authors are encouraged to submit images with articles or information. Please submit images as clear prints, slides, drawings, or in electronic format. Electronic images need to be at least 300 dpi resolution, submitted in at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors are at: http://www.anpc.asn.au/anpc/pdffiles/APCGuideContrib.pdf.

Please send articles, no more than 1200 words, as a MS Word file (2000 compatible) by email to: selga.harrington@gmail.com.

Opinions expressed in this publication are those of the authors and are not necessarily those of the ANPC or its sponsors. Material presented in *Australasian Plant Conservation* may be copied for personal use or published for educational purposes, provided that any extracts are fully acknowledged. Where any material is credited to and/or copyright to another source, please contact the original source for permission to reprint.

Front cover: Endangered *Verticordia* seed in safe hands. Photo: Anne Cochrane.
Printed by: Trendsetting, Canberra.

Contents

From the editor *by Selga Harrington* 2

Pushing the boundaries – Innovation in intervention *by Jason Cummings* 2

Grasping the Nettle: Role of NGOs in plant conservation *by Vicki-Jo Russell AM* 5

The future of Australia's flora: a policy perspective *by Stephen Harris* 6

Managing the matrix – once more with feeling *by Sue McIntyre* 9

Building a South Australian database of biological life histories and disturbance responses *by Doug Bickerton, Michelle Waycott, Ainsley Calladine and Roman Urban* 11

Doing what's best for the ecological community - protection under national environment law *by Matt White* 13

Crossing borders for biodiversity: a focus on threatened species and biodiversity management policy *by Judy West and Belinda Brown* 16

Alpine seed and seedling ecology reveals important implications for management *by Gemma L. Hoyle* 19

21 years of seed conservation in the WA Department of Environment and Conservation: achievements and future directions *by Anne Cochrane and Andrew Crawford* 21

Flora of Australia Online – a continental taxonomic resource for the future of Australian plant conservation *by Helen Thompson and Greg Whitbread* 23

Enhancing and restoring diverse grasslands and grassy woodlands: are we there yet? *by Paul Gibson-Roy* 26

Regular Features

Report from New Zealand Plant Conservation Network 28

Upcoming conferences and workshops 29

Book reviews 30

Information resources and useful websites 31

Research round up 35

ANPC Corporate Members 37

From the editor

Selga Harrington
Parsons Brinckerhoff

Welcome to the autumn edition of *Australasian Plant Conservation*! This is the second edition of *Australasian Plant Conservation* devoted to papers from ANPC's 9th National conference held in Canberra late last year. The conference was entitled *Plant Conservation in Australia: Achievements and Future Directions.*

This edition begins with four thought provoking plenary papers:

- innovation in landscape restoration by Jason Cummings (Greening Australia)
- the role of NGOs in plant conservation by Vicki-Jo Russell (Zoos SA)
- a review of vegetation policy history and future directions by Stephen Harris (Department of Primary Industries, Parks, Water and Environment, Tasmania)
- management of the modified landscape matrix by Sue Macintyre (Australian National University).

These are followed by papers on a range of topics on the themes of Conservation Policy, Plant Conservation Strategies, Ecological Restoration and Threats.

The edition concludes with the regular features: Report from New Zealand Plant Conservation Network, Upcoming conferences, Book reviews, Research roundup; and finally, Information resources and useful Websites.

Happy reading!

Pushing the boundaries – Innovation in intervention

Jason Cummings
Greening Australia Capital Region, JCummings@act.greeningaustralia.org.au

Summary

Given the scale of landscape degradation experienced in Australia, our reliance on our natural resource base and the level of public investment in maintaining our natural resources assets, innovation will be crucial in delivering future landscape regeneration outcomes for the community at the scale required. Over the last three decades Greening Australia has delivered several key innovations that will underpin the future success of current landscape restoration programs, including reintroduction of native vegetation to over-cleared landscapes: the Whole of Paddock Rehabilitation approach, the Grassy Groundcover experience, and new ways of engaging the community. Here I reflect on the lessons-learnt, and particularly what has led to the development of an "innovation culture", from the type of people we engage, to tight funding parameters and the need to remain at the forefront of what we do to ensure our future survival and success.

The not-for-profit approach

Not-for-profit organisations are typically owned by a membership of shareholders with a common purpose. That purpose is not to return profits to shareholders, rather it is to typically deliver a public good outcome. In the case of Greening Australia, our mission is to engage the community in vegetation management to achieve healthy, diverse and productive landscapes. If a not-for-profit organisation is able to run at 'not-for-loss' retained earnings are re-invested in the mission of the organisation, rather than distributed to members as profits. According to the Productivity Commission (2010) innovation is driven by this commitment to a common purpose: 'The purpose-driven nature of 'not-for-profit' activities can give freedom to explore new approaches to achieving that purpose, allowing them to take risks where failure is accepted as part of learning.'

The business model for delivering a successful not-for-profit organisation relies heavily on "sticking to mission", being more efficient and effective at service delivery for investors than any other provider, and ultimately, innovating to continuously stay at the vanguard of best-practice. Today's new idea is tomorrow's normal practice and once a new practice or idea has become main-stream, it is typically more efficient for the business community to deliver.

Case study 1: whole of paddock rehabilitation

Working with graziers on the Southern Tablelands of NSW we have pioneered a new approach to landscape-scale rehabilitation. Instead of spending money on new fences to control grazing, we have worked out a more efficient approach – use the existing fences and pay farmers to control grazing. Whole of Paddock Rehabilitation provides an incentive payment for landholders to change their practices, by resting paddocks for 5 years while we reintroduce native trees and shrubs in widely-spaced belts along the contour. The outcomes include enhanced connectivity for box gum grassy woodlands, reduced erosion and run-off and increased agricultural production from lamb survival and growth in sheltered areas (Cummings et al. 2012).

The Productivity Commission (2010) highlights that innovation in social or community problems often 'requires multi-part and collaborative approaches'. The WOPR model arose from close collaboration between Greening Australia and several key landholders over many years. The key elements of this successful collaboration have included trust, continued long-term engagement and willingness to support each party, and a preparedness to take risks and learn from mistakes. WOPR has blossomed into a program that is now repairing hundreds of hectares of tired agricultural land every year, on more than 54 different grazing properties.

Case study 2: building understory diversity

In 30 years of concerted vegetation restoration efforts, we (in eastern Australia) only really became very good at returning trees and shrubs to the landscape. Of course biodiversity is much more than trees and shrubs. Only recently have there been concerted efforts to focus on more of the 'diversity' in woodlands and grasslands through the reintroduction and establishment of herbs, forbs and other ground-storey plant types. Learning what we could from the 'Grassy Groundcover' pioneering work in Victoria (Gibson Roy 2008), we embarked on a local program to systematically identify and break down the barriers to restoration of diverse grassy systems in the ACT and southern NSW.

We identified constraints related to 'capability' (i.e. we don't know how, or how to do it efficiently) and 'capacity' (i.e. we don't have the seed, or we don't have the money to support us). There was a clear and ever-growing need in the region to be able to restore bio-diverse groundcover. This was being driven largely by the EPBC Act, and its offset requirements, for grassland and grassy woodland developments. What we identified in the industry, before we started our 'Building Understorey Diversity' project was that 'developers' would be required to deliver high quality biodiversity offsets, but in the absence of any capacity to do so (e.g. available seed or people to do it) they were allowed by the community to revert to lowest common denominator outcomes (i.e. lower biodiversity standard offsets).

To bridge this gap we simply started investing in seed supply for grasslands and grassy woodland groundcover species. This included using the approaches trialled in Victoria, and importantly, simultaneously making regulatory authorities and developers aware that we have moved ahead and filled the gap we observed. Before long, we had secured a partnership with Canberra International Airport to trial the reintroduction of diversity to existing native pasture they had on their property. The trial work we are doing with Airport will go a long way to building capability in the ACT and southern NSW for this type of restoration. Subsequent investments from Caring for Our Country and the ACT Government's environment grants program has helped start to build seed supply capacity with the Australian National Botanic Gardens.

The key lessons learnt for us on the innovation front from this project were:

- taking a leadership position and filling an identified gap
- collaborating with partner organisations who had overlapping interests, but clearly different motivations
- the importance of a supporting institutional framework for efficiently transferring best-practice
- learning from others but implementing our on-ground actions using an experimental framework so we learnt as we went along.

Leucochrysum albicans *in full bloom. A seed production area maintained by volunteers and our Seed bank Manager Stephen Bruce (left), pictured with President of Greening Australia Capital Region, Peter Davey (right), at Aranda. Photo: Jason Cummings*

Common threads for innovation

From an organisation management or leadership perspective, there are several aspects that helped to foster a culture of innovation:

- employing inquisitive people that have a passion for delivering solutions
- employing people with science degrees is very useful, as they have a framework to explore and compare possibilities in the implementation of their day-to-day accountabilities
- setting in place a risk management framework, and giving people enough rope to let leadership and risk taking emerge from all levels of the organisation – not necessarily an easy thing to do
- sticking at it, coming back to check on your work, and sharing and learning from failures – in our game there is a long lag time between implementation and adaptive management, this uniquely lends itself to not-for-profit organisations that have stood the test of time as being the key vehicle for innovation
- being open to new ideas, as they can come from anywhere – board members, volunteers, farmers, corporate sponsors, social media etc.

Support your not-for-profit institutions, we have runs on the board, and need the support of major investors in landscape conservation and management, if we are to realise the potential of landscapes in regional Australia to meet the diverse needs of our community.

Acknowledgements

This paper was improved following feedback from Lori Gould, Bindi Vanzella, Brendan Foran and Selga Harrington.

References

Cummings, J., Gould, L., and Fifield, G. (2011) Whole of Paddock Rehabilitation – Landscape Restoration Grows Up. *Australasian Plant Conservation* 20(1): 19-20.

Gibson-Roy, P. (2008) Reconstructing complex grassland on agricultural sites by direct seeding: learnings from a 3 year, field-scale, experimental study. *Australasian Plant Conservation* 16(4): 22-23.

Nambisan, S. (2009) Platforms for Collaboration. Stanford Social Innovation Review. http://leadershiplearning.org/system/files/Platforms%20for%20Collaboration.pdf last viewed 12/02/2013

Productivity Commission (2010) Contribution of the Not-for-Profit Sector. Research Report, Canberra.

Yesterday's Innovation is Today's Business-as-usual

In 2012 Brian Cumberland was awarded an Order of Australia medal for "service to conservation and the environment in the Australian Capital Territory and south east New South Wales region". What made Brian's contribution to conservation and the environment 'above and beyond' business as usual, was the timing of his contribution and the nature of the landscapes and communities he was working with through his 20 year career with Greening Australia.

When Brian first started talking to landholders about reintroducing native vegetation onto their properties, he was often derided, at a time when planting exotic pine trees was the norm. Families had spent generations of effort clearing native vegetation at the time, so the notion of bringing it back was a culturally sensitive one.

In this context, those landholders willing to take a punt on native vegetation were the very earliest of adopters and the leaders amongst their peers. They were taking risks, that came with the potential for embarrassment amongst their peers.

Accordingly, the techniques we used to bring back native trees to those landscapes had to be bullet-proof, as we were not only trying to hold back the decline of biodiversity; we were trying to turn the tide of public opinion on the value of native vegetation.

So 20 years ago Brian was selecting species for our revegetation that had a low risk of failure and quick growth rates, to not only bring native vegetation back to over-cleared landscapes, but also to bring the community along quickly with us.

Across the last 20 years we have tinkered [innovated] with species selection, and now have more than 50 species at our disposal for direct seeding, and match species selection with target condition and pre-existing vegetation types.

The discussion with landholders about reintroducing native species is not novel today, what is novel now is the scale of the reintroduction and its impact on the farm's bottom line.

Grasping the Nettle: Role of NGOs in plant conservation

Vicki-Jo Russell AM

Zoos SA, Adelaide; Email: vrussell@zoossa.com.au

> ***"Do not hire a man who does your work for money, but him who does it for love of it."***
> **…Henry David Thoreau**

Despite the commonly held stereotypes environmental non-government organisations (e-NGOs) are quite a diverse group and cover a broad spectrum of political views and issues. What they share in common is the ability to operate independently of government or politics; though often they rely on government grants to pursue project work. Typically their foundations lie in matters of public, rather than individual, political or commercial interest and often their governance give them a unique ability to plan beyond political or financial time horizons.

E-NGOs have a long and proud history in Australian plant conservation. Arguably the first were scientific societies associated with the establishment of botanic gardens emerging around 200 years ago. When they commenced these highly regarded institutions were typically interested in the collection, display and acclimatisation of Australia's plant life – well two out of three ain't bad! Since this time many e-NGOs have formed; a number of which are still serving their community today. The focus has broadened over time from botanical study and research to promotion and education, advocacy, community involvement, propagation and vegetation management to land ownership and large scale restoration. Australia's plant e-NGOs now have diverse interests and work at many scales from paddock to policy.

The challenge ahead

Given the tremendous community effort to date, how are we tracking? The State of the Environment Report 2011 (SOE 2011) shows that population, range and genetic diversity across all groups of plants is experiencing ongoing decline as broad scale clearing and previous introductions continue to have legacy effects. Though plans at different scales exist they are not met consistently with action and we have not made the progress we might have expected given our investment. Our ability to make evidence-based decisions is still hampered by lack of data and, where we do act on information, progress is painfully slow. Lastly and overwhelmingly, despite this report and many that have come before it, on the whole Australians continue to make most decisions contrary to ecologically sustainable development principles - but readers will know not much has changed for 20 years.

What SOE 2011 also tells us is that we can still make great strides if we act quickly and with resolve over the next 20 years. To be successful we will need to continue to build on the National Reserve System, restore ecological function to vast areas of cleared or degraded land, develop mechanisms to better detect and manage global invasive species, ensure the benefits of healthy landscapes are understood and become a factor in decision making, connect and inform increasingly urbanised populations so they can make more sustainable decisions in daily life and develop stronger models of polycentric governance so that decision making and resources are shared and in the hands of people who can implement in a timely and effective manner while maintaining government's capacity and commitment to their ultimate responsibilities. We must recognise that e-NGOs, by their very nature, are well placed to drive and contribute to many of these necessary outcomes.

Strengths and weaknesses

E-NGOs can go places others can't or won't and when they have to they can go around. They have diverse governance models and are willing to experiment and take educated risks, all critical for driving innovation. E-NGOs are happy to work at and between varying scales, including international, and can accelerate action and adapt relatively quickly. They bring with them committed members, community reach and often extensive partnerships and, networks. They can offer a long-term commitment and with their volunteer-base, passion and a strong focus on outcomes, are often attractive to private funders. In many cases they are already doing the work, they just need more support to make a long-term impact.

E-NGOs have very real constraints however, like any organisation they have their moments, and despite being fiercely cost effective even the oily rag sometimes dries up. They can do lots and be resourceful but often need support for core funding and can't easily manage gaps in periods of funding. Typically e-NGOs have a relatively small workforce and rely on volunteer contributions to drive both their governance and project implementation. For this reason they need generous deadlines and, at times, extra resources to respond to unforseen opportunities; it's best to involve them early. E-NGO staff and members are often driven by values and, at times, will need to work through matters of ethics and priorities to reconcile an acceptable position. E-NGOs also have to work around false perceptions of their motivations and capabilities and can be treated as competition for grant funding, which is typically counterproductive.

Make the most of e-NGOs

Addressing the significant challenges set by SOE 2011 we need all hands on deck and a sector that works faster, adaptively, creatively and inclusively with even less. E-NGOs are well structured to respond to this challenge in partnership with others. So how do we ensure e-NGOs are able to play their part? We need to genuinely value and support everyone's contribution and recognise that no one wins if the sector loses capacity. We will get the best outcomes when we work collectively on common challenges and foster leadership.

Don't take e-NGOs for granted, a number of changes over the past 15 years have made it harder for them to eke out a living. So can we step up to this challenge and ensure we support e-NGOs to contribute and enhance their strengths to respond to the biodiversity crisis? It is worthwhile reflecting on your own organisation's practices. Are you making the most of the e-NGOs available to you and how e-NGO friendly is your approach? To e-NGOS, are you being as strategic as you can be? Are you a viable option for others to partner and are you working well with other e-NGOs? E-NGOs are messy at times (or hard to grasp) but definitely worth it.

A volunteer member of South Australia's Threatened Plant Action Group. Photo: T. Jury

Acknowledgements

My thanks to Jill Woodland (Conservation SA) and David Taylor (Bio-R) for their assistance and to all the great South Australian e-NGOs who provided case studies for the conference presentation.

References

State of the Environment 2011, State of the Environment 2011 Committee. Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities. Canberra, DSEWPAC, 2011.

The future of Australia's flora: a policy perspective

Stephen Harris

Department of Primary Industries, Parks, Water and Environment, Hobart, Tasmania.
Email: Stephen.Harris@dpipwe.tas.gov.au

By examining the origins of the current policy landscape we can better understand intergovernmental dynamics and be better informed about what types of policy developments might contribute to sustaining Australia's native flora.

Vegetation policy history

Colonial period

The Colonial Period was largely policy free with some surprising exceptions. There were for example Acts to preserve game hunting areas, to preserve places of recreation, to prevent spread of weeds, and to prevent the importation of plant diseases. All this was at a time of active expansion of farms and industry.

A problem for these and other policy instruments at the time was that few resources were there to implement, to enforce regulations or to learn – there was a poorly developed bureaucracy and this, combined with a lack of coordination across colonial boundaries choked at birth the few opportunities to progress flora conservation.

1901-1970

Between 1901 and 1970 there were several phases of land development including clearing for farming following the world wars. Governments had a widely acknowledged remit following these events to strengthen economic and industrial performance.

Responses to such major events overshadowed any proposition for advancing vegetation policy. Collateral gains came from other areas such as soil conservation policy.

Establishment of national parks, with New South Wales leading the way, was the primary legacy and these were viewed as refuges for fauna, tree fern glades, waterfalls, scenery and so forth.

Late 1960s and early 1970s

This period marked a paradigm shift concerning nature conservation. Acts and regulations began to be drafted and enacted by different governments.

The year 1974 saw a strongly centralist national government set up the Commonwealth government enquiry into the national estate, which recommended some focus on various initiatives including building the reserve system and recommending funding for systematic vegetation studies in all the states.

The Commonwealth nature conservation bureaucracy was in its infancy at this time and formal state/commonwealth dialogue on these issues was only beginning.

However the importance of national approaches was beginning to accelerate. For example 1973 saw commencement of the Flora of Australia project under the Australian Biological Resources Study in 1973. This is a fundamental program that underpins all our work.

Around the same time a national working group of experts (Endangered Flora Network) developed a list of threatened flora – preceding any legislation for such species in most states and at a national level. Their work, represented in the publications of Leigh and Briggs showed it was possible to have an expert-agreed national threatened species list that at the same time explicitly detailed the geographical information in the states.

1980s and early 1990s

The shift in policy initiative from state-lead to Commonwealth-lead after the early 1980s was profound, affecting flora, vegetation, and environmental policy generally. After 1982 there was an increase in the reach of Commonwealth powers. The states became more clearly bound by the requirements of the Commonwealth - the Franklin Dam case in the High Court extended the Commonwealth's power by virtue of its external powers of responsibilities, in this case under the World Heritage Convention of 1972. From this time intergovernmental issues began to figure prominently in natural resource management policy.

The increase in external treaties and other international obligations has, in turn, devolved considerable work and responsibility back onto states and territories. The Convention on Biological Diversity (CBD) made in 1992 is the chief relevant external treaty. It drives the national biodiversity strategy, the native vegetation framework and a number of other plant related strategies under the subsidiary agreements of the CBD such as the Bonn convention which relates to access to genetic resources and the Montreal process relating to forest policy. The Prime Minister's statement of 1989 recognised the primacy of the states and territories, under the Australian constitution, in protecting and managing the environment. It also recognised the national scale of most problems and the shortcomings of a piecemeal approach. It foreshadowed national consultative forums for discussing the problems and carrying out joint studies. In 1989 the Commonwealth brought together sectional groups under the principles of ecological sustainable development as a way of integrating economic and environmental objectives and lessening conflict.

In 1991 an intergovernmental agreement on the environment was preceded by the communication of principles including the need for cooperative resolution of national issues; maximum devolution of responsibility for regulations consistent with the national interest; the elimination of inefficient Commonwealth/state divisions of functions; and ensuring intergovernmental arrangements are transparent and accountable. Councils of Australian governments (COAG) were born out of special premiers' conferences under the Hawke government. COAG initiatives included the national framework for the management and monitoring of Australian vegetation.

The development of nationally consistent guidelines for access to genetic resources was produced by the Australian government in conjunction with the states and is an excellent example of how state and Commonwealth governments can productively interact on policy formulation. It contained principles for policy development and leaves the detail to the states. The Commonwealth developed, under these principles, and also with reference to the states, the model Access and Benefit Sharing Agreement to apply to access to genetic resources on Commonwealth land. The model was one that could be adopted by all states, thus closing any loopholes that might exist for bioprospectors.

Lessons from recent policy reviews

There is much debate about federalism, but overall there appears to be an overarching trend towards centralism with some periodic small reverses.

Regardless of this, flexibility in having the states address national priorities is the key to encouraging policy innovation. This work needs to have deep roots in scientific and technical policy work.

Some examples of policy innovations

The Northern Territory has a model approach to biodiscovery with its act developed under a nationally consistent approach and its use of Access and Benefit Sharing Agreements for all flora and fauna collecting permits.

Victoria introduced a market based approach to plant conservation with their bush tender approach, including a method of assessing vegetation condition to support offsets. Their condition assessment method has been adopted by several other states for their own ends.

Queensland has a lauded model in their "Delbessie Agreement" for dealing with conservation on leasehold lands that factor in vegetation stewardship and nature conservation outcomes.

Evaluation of policies

Evaluation and feedback is important to policy development because it is how we know what needs improvement. This requires monitoring of what succeeds or fails on the ground.

Recommendations from reviews of vegetation policy and processes done over the last few years have included increasing reserved areas, improving coordination of effort, focussing on protection of wetlands, and development of market-based instruments for protecting biodiversity values. Broad scale vegetation clearing was a major challenge for several states until the 1990s but since then all jurisdictions moved to cease broad scale clearing. Ecologically sustainable development has also been confirmed as a basic underpinning policy framework.

Enhancing the collection of taxonomic data as well as placing effort on the collection of nationally coherent information are particularly noteworthy recommendations highlighting the underpinning importance of long-term basic science.

Some major themes seem to emerge that could improve plant conservation. The first of these is the need to spread responsibilities for vegetation conservation. Respected organisations, such as ANPC, can make an important contribution to the development of policy instruments in the form of technical guidelines and protocols such as has been done with germplasm storage and translocation. Strengthened coordination in vegetation management across local government/NRM/catchment authorities and state government has been advocated in a number of reviews.

A second major theme is the continuing need to strengthen scientific and technical policy work recognising that good science will benefit policy outcomes.

Monitoring and policy evaluation can be better connected to scientific and technical effort. Support for monitoring and collection of biological data, preferably long-term, and recognition of the underpinning importance of continuing work on plant and vegetation community taxonomy is crucial to flora conservation. The Terrestrial Ecological Research Network program is also building capacity for collecting important biodiversity data and formalising the maintenance of biodiversity data in the Bureau of Meteorology indicates a long term perspective.

Thirdly, the development of a national reserve system remains one of the priorities for action under Australia's biodiversity conservation strategy "protecting biodiversity". A 1977 study of Tasmanian coastal heathlands recommended areas for reservation. A reassessment twenty years later revealed a spectacular improvement in reservation status. On the other hand, in the intervening period, almost all the areas had been infested by *Phytophthora cinnamomi* and had become floristically poor. Monitoring, research and active management is therefore an ongoing task.

Finally, the catchment approach to conservation has morphed into a landscape scale approach but in reality they can be viewed as nested at different scales. All scales need to be integrated. Work on species ecology will still be important in understanding the operation of landscape systems.

Conclusion

Past policies will hopefully provide an enduring framework for the future, including:

- a national outlook in our underpinning scientific tools – the Australian Biological Resources Study and the National Vegetation Information System
- agreement about the incorporation of ESD principles
- acceptance by governments of a national coordination role in flora conservation
- policy innovation and sharing by states
- establishment of the Natural Heritage Trust
- strong regional involvement
- an acceptance of lesson learning and preparedness to change and improve policy.

What of the future of Australia's flora? Just as we need to have continuing scientific research and development of innovative plant management techniques, then this needs to be paralleled by constantly improving policy development. Adversarial approaches characterising some issues in the past will not work. Strong cooperative engagement between scientists, industry groups, land management groups and government policy makers will advance the open-ended project that is the conservation of Australia's flora.

Managing the matrix – once more with feeling

Sue McIntyre

The Fenner School of Environment and Society, Australian National University, Canberra ACT.
Email: Sue.McIntyre@anu.edu.au

While much work has been done to improve land management practices in agricultural regions, the majority of landscape – the matrix – is still largely untouched by restoration. This paper discusses management of the landscape in the face of uncertain climatic changes and continuing concern about biodiversity and ecosystem function. It focuses primarily on grassy wooded ecosystems, which have been particularly depleted by agricultural development.

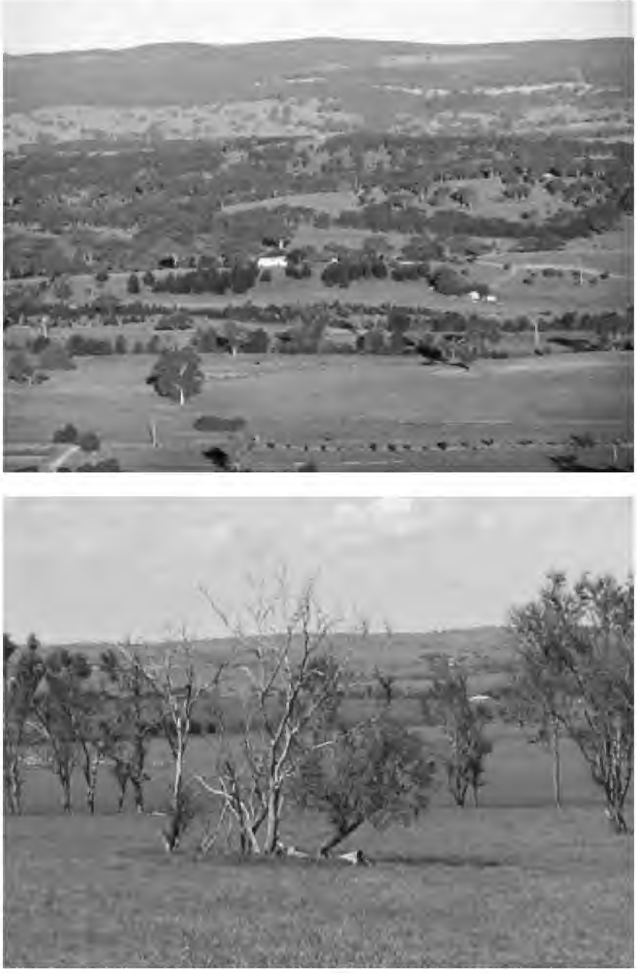
I suggest that conservation management priorities are not fundamentally changed by imminent climate change. The principles of maximising habitat extent, condition and connectivity still apply, and landscapes highly modified by intensive land uses are more vulnerable to loss of native species through climate change than intact landscapes.

Proposals to focus management on the modified landscape matrix in fragmented and variegated landscapes in the early 1990s have been variously addressed through localised plantings for biodiversity, grazing management, and engineering to improve soil and water functionality. These actions tend to take place over limited areas, and are yet to produce transformations in landscape functionality, or stop the decline of native species, and there is a need to renew our efforts in whole-of-landscape management.

While economics, policy and climate change will interact to determine most land use patterns, there is scope to moderate our practices within land use types. For example, reductions of fertilizer use in natural pastures will encourage dominance of perennial native plants and regeneration of eucalypts, with benefits to soil, microclimate, and native plants and animals. If mature paddock trees in cropped paddocks are protected from cultivation, fertilizer and livestock, the habitat value of cropping areas will be immeasurably higher. These are approaches to reducing the impacts of intensive agricultural land uses.

Agricultural landscapes with a matrix of intensive land use are dominated by high-input agriculture such as crops and fertilized pastures, and are highly valued for their economic productivity. The trade-off is that they are contributing little to native conservation, or a range of ecosystem services. If the latter were to be catered for, there would need to be significant conversion of the landscape to one supporting a smaller area of intensive land uses and large areas of extensive land uses.

Extensive land uses are those that do not attempt to maximise production, using larger areas of land and fewer inputs and costs e.g. unfertilized pastures, grazed woodlands, conservation reserves. Under extensive land use, less of the biomass produced by plants is diverted to human needs, and the retained primary production can contribute to the stabilisation of ecosystem processes with consequent provision of services other than production. A simple example is the tough, perennial ground cover provided by unfertilized pastures that provides good protection from soil erosion, but lower animal productivity. The very high cost of conversion of intensive to extensive land use due to loss of production income has been a very obvious barrier to landscape transformation of this type.



(top) Landscape with a mix of extensive landuse (grazed and ungrazed forest and woodland) and some intensive landuse (fertilized pastures) evident in the foreground. (bottom) Landscape with a matrix of intensive landuse (fertilized pastures and crops) with no extensive landuse evident. Photos: Sue McIntyre

Nonetheless, we need to understand the consequences of no action, and be well armed with an awareness of what can be done in order to effectively capture opportunities for environmental gains as they arise. For example, major carbon sequestration activity could be applied as a high input, intensive land use activity, or be very biodiversity-friendly, depending on its implementation.

Ecologists have been reluctant to be specific when asked how intensively a landscape can be used before it is considered unsustainable. Limits to intensification that were identified ten years ago are still standing as general principles, but are too challenging of our current use of landscapes to be widely propagated. Providing 30% of the landscape as wooded habitat has been broadly accepted at regional levels, but if the soils are suitable for cropping, limiting intensive use to 30% of the landscape where it has already exceeded this level is unlikely to happen. Nonetheless, recognizing these limits to intensification invite us to acknowledge problems that particular landscapes are facing, and to consider other compensating approaches e.g. to focus restoration with a design emphasis on maximizing connectivity for wildlife.

Creating significant areas of low input land use can be seen as an opportunity for reinvigorating our conservation management. This extends conservation practice well beyond the domain of wilderness and leaving tracts of bushland untouched. Even with vigilant weed control, exotic species will be part of all newly extensified areas and they are not always to the detriment of native species. Production opportunities will also exist for people – grazing, timber, wild game harvesting, plant and seed resources. We need to merge utilization and conservation philosophies, drawing from the Indigenous values of harvesting and nurturing, European cultural landscapes and modern science, both agricultural and ecological.

More complex, subtle actions for restoration and management that will be of increasing importance include:

- Substantially replacing tree planting with natural regeneration and simple seeding techniques that reflect a more sophisticated understanding of natural ecosystems and the conditions in which persistent populations can establish. We need to be selective in the choice of restoration sites, taking into account nutrient status and past history. This will increase the chances of success and resource wastage.
- Assisted dispersal of functionally important and depleted plant species needs to be part of our restoration management because plants are much more strongly affected by habitat fragmentation than fauna.
- Use of fire to manage exotics, provide regeneration opportunities and manage vegetation structure.
- Use of tree thinning to manage dense regrowth in post-production landscapes where appropriate, to improve plant and animal biodiversity and contribute to aesthetic qualities.

These approaches present a conceptual and technical challenge for scientists and land managers alike, but are pathways to a deeper cultural affinity with the Australian environment.

References

McIntyre S (2008) The role of plant leaf attributes in linking land use to ecosystem function and values in temperate grassy vegetation. *Agriculture, Ecosystems and Environment* 128, 251-258.

McIntyre S (2011) Ecological and anthropomorphic factors permitting low-risk assisted colonization in temperate grassy woodlands. *Biological Conservation* 144, 1781-1789.

McIntyre S, Hobbs RJ (1999) A framework for conceptualizing human impacts on landscapes and its relevance to management and research models. *Conservation Biology* 13, 1282-92.

McIntyre, S. & Hobbs, R. J. (2000) Human Impacts on Landscapes: matrix condition and management priorities. In: *Conservation in Production Environments: Managing the Matrix. Nature Conservation 5* (eds J. L. Craig, N. Mitchell & D. A. Saunders) pp. 301-307. Surrey Beatty and Sons, Chipping Norton.

McIntyre S, McIvor JG, Heard KM (Eds) (2002) *Managing and Conserving Grassy Woodlands*. CSIRO Publishing: Melbourne

Skinner AK, Lunt ID, McIntyre S, Spooner PG, Lavorel S (2010) Eucalyptus recruitment in degraded woodlands: no benefit from elevated soil fertility. *Plant Ecology* 208, 359-370.

Smith, F.P., Prober, S.M., House, A.P.N. & McIntyre, S. (2012) Maximizing retention of native biodiversity in Australian agricultural landscapes - the 10:20:40:30 guidelines. *Agriculture, Ecosystems and Environment*, in press.

Building a South Australian database of biological life histories and disturbance responses

Doug Bickerton[1], Michelle Waycott[1,2], Ainsley Calladine[3] and Roman Urban[1]*

[1] Department of Environment, Water and Natural Resources, [2] Adelaide University; [3] State Herbarium of South Australia;
**Corresponding author Email: doug.bickerton@sa.gov.au*

Background

In the wake of the Victorian bushfires, there has been a demand by the South Australian public for regular fuel load reduction, including many stands of native vegetation. The Department of Environment, Water and Natural Resources (DEWNR) now has annual prescribed burn targets, and our fire planners and ecologists, wishing to take advantage of this opportunity to maximise ecological benefits, began discussions with our Nature Conservation Branch on ways to collate and utilise biological life history information and guide fire management.

Currently Park managers are working with fire, water and forestry agencies to plan and coordinate multi-hectare burns. Additionally, local government and transport agencies now have increased authority to slash or clear roadside vegetation with reduced vegetation clearance approval restrictions (unless EPBC-listed taxa are present). We saw a need for delivery of advice on threatened species management to a host of end-users, but we realised the paucity of knowledge on survivorship traits of South Australian species available to our own ecologists, as well as other agencies.

We also knew from experience that many plant species have flowering or germination triggers that are either not fire-related or additional to fire or smoke triggers; however apart from some well-studied taxa, this information was not being captured. Finally, we saw a benefit in expanding the database to include responses of threatened fauna, so we felt that, rather than limit ourselves to a fire response database, we should develop a database of life histories and disturbance responses for rare and threatened flora and fauna in South Australia, to be used by:

- Fire ecologists and planners
- Water and forestry agency environmental officers
- Local government and transport agency road maintenance planners
- Threatened species recovery officers
- Landscape ecologists and revegetation practitioners
- Environmental consultants.

Development of the database

In scoping the project, we identified our sound knowledge of threatened species distributions, and our large Herbarium record database, but also patchy species–specific monitoring data for many threatened species, and limited ecological data. When researching the vital attribute databases compiled interstate, we found some issues (similar to the Western Australian experience as noted in Shedley, 2011):

- South Australian endemic taxa by default are not included in interstate databases
- they are generally limited to fire response
- they do not identify the variation in disturbance response that occurs across a species' distribution, at different life stages or in different habitats
- they are generally insensitive to the variation in response to differing fire regimes, i.e. intensity, duration, seasonal timing, length of time between fires
- little data is available on seed bank dynamics (especially seed longevity and viability) and age to senescence
- the fields required to populate fire response databases in particular are often complex and potentially confusing for many of our anticipated end-users, as well as many of the field experts that we wanted to help us build our brave new database.

Consequently we chose to conduct a pilot project, trialling a compilation of expert opinion and knowledge on threatened species from one South Australian region, and evaluate ways to combine and utilise the data. We chose to focus on the Adelaide and Mount Lofty Ranges (AMLR) Natural Resources Management Region. This region is relatively small in comparison, but is the most densely populated, arguably the best resourced, and definitely the most studied in ecological terms, because of its proximity to three large Universities. And finally, because of the large population base, it is subject to the most political pressure for prescribed burns to be conducted.

In a complementary process, flowering and fruiting data sourced from herbarium vouchers and specimens was scored and used to verify expert opinion and fill gaps in knowledge. Seed biology data from the Seed Conservation

Centre of SA was also used, and in some instances, information in Recovery Plans and selected ID reference books and field guides was sourced.

A matrix of attributes was developed, beginning by simplifying many of the standard fire response attributes, for the benefit of our volunteer field experts, and also adding many new ones such as the seed biology data. Finally, we added a “Comments” column for most fields, to allow us to capture as much detail as possible.

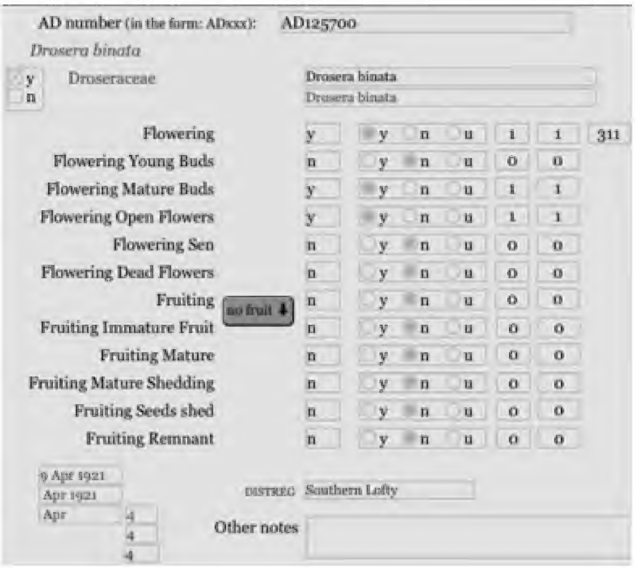
The Herbarium voucher and specimen search was conducted in the first half of 2012. In this search, specimens were viewed and evidence of buds, flowering or fruiting was recorded, along with voucher information on date and location of collection, habitat description and other relevant comments regarding recent fires or floods. The AMLR Region has 23 EPBC-listed and 230 State-listed rare or threatened plant taxa, and we included another 5 taxa highlighted as high priority for the region.

Expert workshops

Four expert knowledge workshops were then organised; loosely arranged in logical plant groups with respect to life history attributes:

- trees and shrubs (mostly)
- orchids
- ferns and allies, grasses, sedges and rushes
- other herbaceous plants (mostly).

A group of four to six experts attended each workshop. Attendees were sent a spreadsheet in advance and invited to study or fill in the spreadsheets, and bring along relevant field notes or reference books. Some reference information was also used by the project facilitators to populate some fields in preparation for the workshops.



AD number (in the form: ADxxx): AD125700

Drosera binata

● y
○ n

Droseraceae

Drosera binata

Drosera binata

Flowering	y	● y ○ n ○ u	1	1	311
Flowering Young Buds	n	○ y ● n ○ u	0	0	
Flowering Mature Buds	y	● y ○ n ○ u	1	1	
Flowering Open Flowers	y	● y ○ n ○ u	1	1	
Flowering Sen	n	○ y ● n ○ u	0	0	
Flowering Dead Flowers	n	○ y ● n ○ u	0	0	
Fruiting	n	○ y ● n ○ u	0	0	
Fruiting Immature Fruit	n	○ y ● n ○ u	0	0	
Fruiting Mature	n	○ y ● n ○ u	0	0	
Fruiting Mature Shedding	n	○ y ● n ○ u	0	0	
Fruiting Seeds shed	n	○ y ● n ○ u	0	0	
Fruiting Remnant	n	○ y ● n ○ u	0	0	

9 Apr 1921

Apr 1921

Apr 4

4

4

DISTREG Southern Lofty

Other notes

An example of the score cards used to record flowering and fruiting data on herbarium vouchers

The workshops were supported with a team of three to four people facilitating, recording and providing internet access to any spatial, herbarium, ID and other relevant reference information. The comments we recorded for each database field proved useful following the workshops, allowing us to correct for subjectivity in answers, or more importantly to change and adapt the fields as we progressed, giving them more relevance.

A report was subsequently compiled, including an analysis of the data identifying vital attribute clusters of life history traits, growth forms, flowering and fruiting times, as well as highlighting data gaps for key traits. By combining the flowering and fruiting data for key species, optimal prescribed burn times can be ascertained.

Future directions

In the next phase of the project, it is intended to add data from the following sources:

- fire ecologists’ monitoring data
- fire scar history data, cross-referenced with herbarium vouchers
- research literature on species, genus or family traits and disturbance responses.

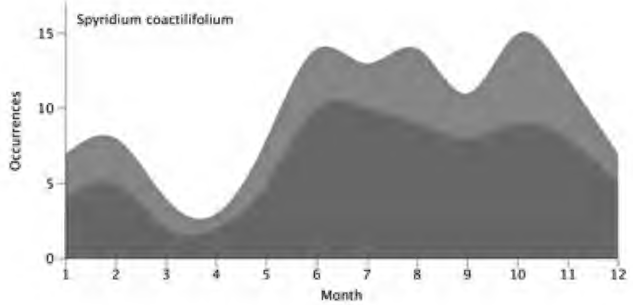
At a later stage, the intention is to include disturbance response information for fauna, and to expand to other regions. The database will be added to DEWNR’s Biological Databases of South Australia (BDBSA), to provide direct and automatic links to future changes in nomenclature, conservation status or distribution.

DEWNR’s Fire Management Branch is supportive of the outcomes of the pilot project report, and will assist in taking the project to the next phase. Other DEWNR staff wishing to utilise the Vital Attributes data will be given access to the relevant fields in the BDBSA; and select staff will be given authority to make updates. Active engagement with regional DEWNR staff would be most successfully achieved through a short series of workshops and presentations.

Once the database is linked to the BDBSA, other State agencies, local government, consultancies and private individuals will also be able to access the data on request via a website link, as is currently the case with other BDBSA data.

Discussion

The Herbarium search was useful in providing or validating data on flowering and fruiting times, as well as locational and habitat information, and for many species, it was able to fill gaps in expert knowledge. While a useful source, the Herbarium search is slow and time-consuming. Since collectors often fail to record on the voucher the life stages of the specimen collected, each specimen must be viewed individually. The usefulness of the information relies



Herbarium records of flowering times for Spyridium coactilifolium *(dark grey= buds/flowers; light grey= fruiting)*

on the quality and quantity of collections, which are not always representative. For example, many collections are made because of some unusual aspect in flowering season or location.

In general, a workshop environment provides the opportunity for participants to clarify the purpose of the workshop and misunderstandings about the process. Workshops allow a focus for participants without distractions, and a faster accumulation of data. Disagreement can be debated and consensus can be reached. Workshops can be adaptive; the lessons learnt can be used to change subsequent workshops, or even the current workshop mid-stream.

On the other hand the reliability and degree of subjectivity of workshop-sourced data is dependent on the experts available on the day. And the specificity of their knowledge is not always adaptable to the required outcomes. Finally, the data being recorded is usually observational, seldom empirical. Hence the need to validate the findings with secondary sources, e.g. herbarium vouchers, fire scar history, seed bank data etc.

The additional information recorded in the "Comments" column also allowed us to identify subjectivity, and make adjustments if necessary; which fortunately was rare. More importantly, our support team was able to lead and support the discussion, keep a check on the answers and probe for more detail to clarify a point.

In conclusion, it is important to recognise that the product that arises from this work is not a prescriptive tool in itself, rather a resource to inform decision making. It will not be a one-size-fits-all because compromises will still need to be made, but they will be informed compromises. For example, the optimal management regime for a threatened species will still at times be at odds with the perceived need for asset protection, but the final decision will be more suitable to both.

Reference

Shedley, E. (2011). *Fire Responses of Threatened Flora in Western Australia. Final Report.* State NRM Project 09029 – Emergency Recovery Actions for Highest Priority Threatened Flora. Department of Environment and Conservation, Western Australia

---

Doing what's best for the ecological community - protection under national environment law

Matt White

Department of Sustainability, Environment, Water, Population and Communities, Canberra
Email: matthew.white@environment.gov.au

National listing and protection of threatened ecological communities (TECs) under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) is a potent protection and conservation tool that:

- raises awareness of the most threatened ecological communities (ECs) in Australia as 'matters of national environmental significance'
- acts to protect them from significant impacts likely to cause further decline
- aims to leverage research and conservation funding and promote recovery through government and community efforts.

The Department of Sustainability, Environment, Water, Population and Communities and national Threatened Species Scientific Committee work together on TEC listings. Summarised below is: the progress in building a comprehensive and representative national TEC list; some benefits and challenges; and efforts to identify potential gaps.

Progress in protecting TECs under national law

As a key part of the national approach to landscape-scale threat abatement and conservation, TEC listing has been accelerated. Sixty-one TECs now receive protection under national law, including 27 in the past 5 years; another 16 are under assessment.

Because a broad landscape approach is often taken to national definition and listing, the national TEC list represents more than 150 communities recognised as threatened by states and territories; and over 4.6 million hectares of 'protected environment' across various land tenures (including private land).

Information provided on TECs has also become more comprehensive to aid on-ground identification, environmental decision-making and promotion/education. As well as the conservation status analysis, listing information now includes: key diagnostic characteristics (biotic/abiotic); comprehensive descriptions of threats and known ecological processes; condition/quality thresholds; survey guidance; surrounding landscape considerations (e.g. buffer zones); priority research and conservation actions; and, how the national TEC relates to other classification systems and state listings. This is often supplemented by fact sheets/guidelines and recovery plans.

The full national TECs list and associated information is on the national Species Profile and Threats Database (SPRAT) at: www.environment.gov.au/cgi-bin/sprat/public/publiclookupcommunities.pl

Lowland Rainforest of Subtropical Australia – listed under the EPBC Act in November 2011. Photo: Matt White

Benefits of national protection

Foremost, listing provides legislative protection and national recognition. This raises the TEC's profile and improves awareness of component species, processes, threats and priority conservation actions. Importantly, actions likely to result in significant impacts are referred to the Commonwealth for approval. The approval process aims to determine whether a proposed action is acceptable and avoid significant impact, or mitigate/reduce threats, or offset adverse impacts when unavoidable. This is supported by strong compliance measures. TECs generally trigger EPBC Act referral for major developments by large companies and governments such as: urban development; mining/gas projects; new/expanding roads and infrastructure.

National TEC listing may also guide and stimulate opportunities for research and improved threat abatement and restoration – in particular, through Australian Government initiatives such as Caring for our Country (see www.nrm.gov.au). For example, since 2008 the Environmental Stewardships Program has fostered conservation of over 58 000 hectares of five national TECs at 580 sites.

TECs provide 'whole-of-system' protection that complements conservation mechanisms for individual species. For example, the 'Littoral Rainforest and Coastal Vine Thickets of Eastern Australia' provides habitat protection for over 60 threatened flora and fauna, plus many more species not individually protected. TEC listing also protects vegetation types not well represented in conservation reserves and private land remnants that foster connectivity and ecological processes in-between reserves or other protected areas (e.g. 'Lowland Rainforest of Subtropical Australia' TEC protects remnants outside of the reserves that form the 'Gondwana Rainforests of Australia' world heritage place).

Challenge of defining a TEC for national protection

The broad EPBC Act definition for an EC allows flexibility in describing TECs to maximise conservation benefits. Nevertheless, ECs are complex to describe and there are a range of scales at which they can be defined. Each TEC description is developed on a case-by-case basis to be scientifically rigorous, legally clear and understandable to land managers.

Key threats often operate at a broad scale. National listing in recent years has, where feasible, moved towards a landscape- scale or systems-based approach, including grouping smaller vegetation units or sub-communities. However, smaller TECs are still national assets and also remain strong candidates for national protection.

Regardless of scale, national extent must be clearly defined and reflect national distribution (irrespective of jurisdictional boundaries). While a TEC may have a broad extent, key species, structure and function typically remain the same across the full range.

Examples of landscape-scale national TECs that cover vast areas and ecological systems across several jurisdictions include: 'Grey Box Grassy Woodlands' and 'Coolibah-Black Box Woodlands'. Assessment of a major river system for the first time as a potential TEC, the 'River Murray and associated wetlands, floodplains and groundwater, from Darling River to sea', is a systems-based approach.

So where are the gaps in the national list? - Informing priorities for listing

National TECs include grasslands, shrublands, woodlands, forests and wetlands. Some habitat types and regions are well represented - for example, all broad-range temperate-lowland grasslands in south-eastern Australia, recognised among the world's most threatened ecosystems, are now protected; similarly, temperate grassy woodlands through the wheat-sheep belt of south-eastern Australia. However, gaps in the national list are known for some types of communities and in some regions; others require identification and prioritisation.

Priority TECs for listing include those in areas where biodiversity has been depleted (e.g. heavily cleared areas) and/or facing substantial threats (e.g. rapid development). The density of EPBC referrals over the past decade indicates the major development areas are: close to major urban centres; east coast and inland of ranges from Cairns to Adelaide; the Swan Coastal Plain, Geraldton and Exmouth-Pilbara.

Other priority TECs are those that represent habitat types or regions under-represented within the National Reserve System or through other protection mechanisms; and/or, in areas where TEC protection and recovery will connect conservation areas or enhance ecological resilience through maintaining or restoring ecological function, critical habitat, wildlife corridors and/or refugia.

Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory. Photo: Matt White

A heavy reliance on public nominations has resulted in a strong foundation for the national TEC list. However, it is timely to take stock. Australia has not been systematically divided into well-defined ecological communities that are assessed for threats at the national level. To complete a national TEC list requires efficient resource use, careful prioritisation and rigorous definition and analysis. In recent years gaps have been strategically identified by: analyses of national and state vegetation datasets; identifying TECs on state/territory lists that are highest priorities for national protection; and two major workshops.

A vegetation gap analysis by the Department revealed:

- bioregions in south-west Western Australia (e.g. Avon Wheatbelt) and southern Victoria/South Australia (e.g. Victorian Volcanic Plain) show loss of >70% since European settlement in several major vegetation groups. Various TECs are listed or under assessment in these regions but others require future consideration
- based on threatened Victorian Ecological Vegetation Classes potential national gaps include mallee and herb-rich woodlands
- analysis of NSW databases (e.g. Benson, 2006) highlighted coastal swamps, floodplain/riparian forests and ironbark-woodland communities that are not adequately protected
- rainforest/vine thicket gaps may include: Queensland deciduous vine thickets; Tasmanian cool temperate rainforests; dry rainforests in NSW/Victoria; and, North Kimberley lowland springs/floodplain rainforest.

The Department is working with state departments and scientific committees to facilitate consistency between jurisdictional lists and identify priorities for national protection. Two state-endemic TECs have been listed ('Claypans of the Swan Coastal Plain' and 'Broad-leaf tea-tree woodlands in North Queensland') and five more are under assessment.

A workshop in 2009 with 36 experts examined processes and priorities to kick-start national listing of marine TECs. Giant Kelp Forests (listed in 2012), were agreed as an excellent starting point and other priorities recommended included sea-grass meadows and saltmarshes (under assessment) (TSSC, 2009).

A National TECs Strategic Workshop in March 2012 brought together 50 experts and stakeholders, including from state/territory agencies and scientific committees (TSSC, 2012). The workshop highlighted various terrestrial vegetation and aquatic communities or systems that may benefit from national protection, providing guidance for future TEC nominations (www.environment.gov.au/biodiversity/threatened/publications/workshop-strategic.html). Some of the suggested priorities for national protection are very broad groupings or complexes.

The next step is to define discrete ecological communities and confirm whether they meet threatened listing criteria. The workshop also endorsed guiding principles for TEC nominations - this 'Prioritisation Framework' was published on the Department's website for the 2013 nomination round (http://www.environment.gov.au/biodiversity/threatened/pubs/framework-for-prioritisation-ec.pdf).

Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains – listed March 2012. Photo: Matt White

Conclusion

National TEC listing is a robust and efficient environment protection and conservation tool. Listing TECs can protect species, natural landscapes and ecosystem services on all land/sea tenures. As 'matters of national environment significance', TECs trigger the protection provisions of the EPBC Act and complement and guide other conservation and recovery initiatives.

There is significant value in a strategic approach to future EPBC Act protection through identifying and assessing high priority TECs that are not well protected nationally. Initiatives are underway to identify priorities but work is ongoing.

References

Benson J.S (2006). New South Wales Vegetation Classification and Assessment: Introduction – the classification, database, assessment of protected areas and threat status of plant communities (www.rbgsyd.nsw.gov.au).

TSSC (2009). Threatened Marine Ecological Community Workshop Report, Canberra. http://www.environment.gov.au/biodiversity/threatened/publications/workshop-marine-communities.html

TSSC (2012). National Threatened Ecological Community Strategic Workshop Report, Canberra. http://www.environment.gov.au/biodiversity/threatened/publications/workshop-strategic.html

---

Crossing borders for biodiversity: a focus on threatened species and biodiversity management policy

Judy West and Belinda Brown

Department of Sustainability, Environment, Water, Population and Communities, Canberra ACT

Email: judy.west@environment.gov.au

Introduction

How do we manage for threatened species when all too often state borders and legislation can prescribe a siloed approach? How do we prioritise our local threatened species conservation efforts if just across the border there are large and well-represented populations?

Policy setting for threatened species management is largely a question of scale, with legislative and policy trends ranging from the local, through regional, national to global scale. This is a policy challenge to grapple with as we collectively move towards landscape level and regional approaches as part of biodiversity management. It is also a management challenge in the face of environmental change, which does not 'respect' borders. We explore here some of the issues in conservation management including difficult decisions around resourcing.

Conservation challenges

Cross-border conservation

How do we manage for species recovery when the species threatened in one jurisdiction is not recognised with the same status in another jurisdiction? *Grevillea ilicifolia* provides a challenging case of cross-border management. The species occurs in south-eastern South Australia, western Victoria and limited areas of southern New South Wales. *G. ilicifolia* is found in similar mallee habitats in each state and is impacted by similar threats, primarily clearing and grazing especially by goats. The species is widespread in SA and Victoria and not recognised to be under conservation threat, but it has recently been listed as critically endangered in NSW, where there is only one population known to be extant (see http://www.environment.nsw.gov.au/determinations/grevilleailicifoliasubspilicifoliaFD.htm).

What sort of focus should the conservation manager place on the NSW population? Given major decline in potential habitat, and likelihood of low reproductive rates, what level of investment should be made to conserve these plants? What is the incentive for managers to commit resources to recovery of the NSW population when the species itself is not under threat?

Data curation from Australia's Virtual Herbarium and tools like the Atlas of Living Australia (ALA) provide the basis to support cross-border species exchange of information (see http://bie.ala.org.au/species/Grevillea+ilicifolia+subsp.+ilicifolia). These types of national infrastructure are required to enable and support conservation planning and decision making.

Conserving infra-specific taxa

There are many situations where taxonomic uncertainty introduces complexities in threatened species conservation; this can be accentuated in cases of infra-specific taxa with restricted distributions. *Tectaria devexa*, a terrestrial fern known from two varieties, poses a number of issues for conservation:

- *T. devexa* var. *devexa* occurs in southern Asia from Sri Lanka through Malesia to Vanuatu, and the Rockhampton area of central coastal Queensland. The Queensland populations of var. *devexa* are restricted to limestone caves, and with the total number of plants being less than 50 individuals, the taxon is regarded as precarious, and is listed as endangered under the Queensland *Nature Conservation Act 1992.*
- *T. devexa* var. *minor* is known from Sri Lanka and Christmas Island (Indian Ocean). On Christmas Island it occurs in deep soils overlying limestone; the total number of mature individuals appears to be less than 500, with each population consisting of around 150 plants. It is listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.

There is some taxonomic uncertainty around the status of var. *minor*. While some fern specialists regard it as a separate entity (e.g. Holttum, 1991; DuPuy and Orchard 1993), others (e.g. Zink 2006) have not recognised the variety. The level of uncertainty may be partly due to workers not having access to material from the total geographic and morphological range, but does however raise the question of whether Australia has a unique taxon existing on Christmas Island. Given the general close relationships of the rainforest flora of Christmas Island to that of southern Asia, where *T.devexa* occurs only on limestone, it is not unlikely that this fern originated from the Sri Lankan region.

The application of some basic genetic diversity and phylogenetic analyses would clarify relationships and readily determine the status of the two *T. devexa* varieties in Australia. This knowledge would greatly assist managers in deciding whether for instance the taxon on Christmas Island warrants special conservation attention and resources.

Ex-situ collections and collaborations

The conservation of the perennial Small Purple-pea (*Swainsona recta*) has benefited greatly through ex-situ science and improved knowledge of its basic biology and ecology at national level. The species occurs in NSW, ACT and Victoria – previously widespread but now known from only 26 sites and less than 10,000 plants - and listed as endangered under NSW, ACT, Victorian and Commonwealth legislation. The first Recovery Plan of 1995 stimulated population genetics research and has informed the 2012 National Recovery Plan (http://www.environment.gov.au/biodiversity/threatened/publications/recovery/swainsona-recta.html), which recognises the necessity of maintaining genetic diversity across the species' range. Genetics research (Buza et al, 2000) resulted in some key findings relevant to fragmented populations:

- the species is not genetically depauperate
- reduction in population size led to loss of rare alleles in small remnant populations
- small populations showed elevated levels of inbreeding
- decreased fitness expressed as reduced germination
- tetraploidy doesn't provide any protection from genetic erosion.

In addition, detailed studies and translocation activities reveal morphological differences between the northern and southern populations, raising concern about mixing genetic material. This deeper knowledge illustrates the importance of working across the entire distribution of a species, and highlights care is needed when translocating material within the natural range of a species.

In the case of *Swainsona recta*, a collaborative project involving the Australian National Botanic Gardens, ACTEW Corporation, Eco Logical Australia, OEH NSW and ACT Conservation Planning and Research has resulted in seed collection, seed banking and propagation of plants for translocation to an offset site helping to secure the future of this species. Building such expertise and capacity by studying and growing Australian plants contributes to threatened species conservation through collaborations with local and regional partners.

Regional approaches

Some threatened species conservation challenges are more readily resolved by taking a regional approach. The Australian Alps National Parks (http://www.australianalps.environment.gov.au), recognised as a major world centre of plant diversity and a refuge for alpine and sub-alpine flora and fauna, provides a good example of cross-jurisdictional cooperation. It has an active program of cross border co-operation: planning and projects for practical on-ground work around natural resource management, climate change and tourism.

The Australian Alps are part of the Great Eastern Ranges Initiative (http://www.greateasternranges.org.au), similar to the Gondwana Link initiative, which aims to maintain, improve and reconnect 'islands' of natural vegetation. More recently the National Wildlife Corridors Plan, an Australian Government initiative, outlined a new design for whole of landscape sustainable management, including coordination and collaboration with a range of local stakeholder, industry and government, and including conservation of native plants over small to large scales, while supporting multiple land uses such as conservation, farming and forestry (http://www.environment.gov.au/biodiversity/wildlife-corridors/index.html).

Conclusions

Increasingly, the protection, conservation and recovery of ecosystems and native species will rely on a coordinated approach and cooperation between stakeholders. To inform conservation management and help improve outcomes, there is a place for increasing knowledge and information exchange; including application of modern tools such as genetic studies and the ALA in sharing information more efficiently. Asking questions upfront about species range, ecological and biological information, resources and management practices, at local, landscape and national scale helps inform on-ground management.

Providing for cross-tenure, cooperative and regional approaches to decision making in relation to threatened species and broader biodiversity management, will contribute greatly to in-situ and ex-situ efforts for conserving ecosystems and native species. It also allows investigation of the need for and where feasible implementation of interventionist programs, such as captive breeding and propagation, for threatened species in decline.

Seed collection, seed banking and propagation of Swainsona recta *plants for translocation to an offset site has helped to secure the future of this species. Photo: M.Fagg*

References

Buza, L., Young, A. and P.Thrall (2000) Genetic erosion, inbreeding and reduced fitness in fragmented populations of the endangered tetraploid pea *Swainsona recta*. *Biological Conservation* 93: 177-186

DuPuy, D.J. and Orchard, A.E. (1993) Dryopteridaceae in *Flora of Australia: Oceanic Islands 2* Vol.5, pp. 558-562. Australian Government Publishing Service, Canberra.

Holttum, R.E. (1991) Tectaria group in *Flora Malesiana* ser.II vol.2 pt.1: 57-58.

Zink, M.J. (2006) Dryopteridaceae in *Flora of Ceylon* XV, Part A: 162-163. Science Publishers.

Alpine seed and seedling ecology reveals important implications for management

Gemma L. Hoyle

Division of Evolution, Ecology and Genetics, Research School of Biology, Australian National University, Canberra, ACT.
Email: gemma.hoyle@anu.edu.au

Our unique alpine flora faces an uncertain future

The Australian Alps are located in southeast Australia and occupy *ca*. 25,000 km^2. Recently awarded inclusion on the National Heritage List, the Australian Alps are home to a highly unique flora, including many endemics. However, warming associated with climate change is occurring more rapidly above the treeline than at lower elevations, and alpine areas are predicted to experience above average warming in the future (Kullman, 2004). Indeed, the Australian Alps have seen a rise in air temperature of *ca*. 0.2°C per decade over the last 35 years and mean temperature predictions for 2050 lie between +0.6 and +2.9°C relative to 1990 (Hennessy *et al*., 2003).

Evidence suggests that Australian species are being forced to migrate into cooler, wetter areas as a consequence of climate change. However, alpine plants are geographically localised and many are already at the limit of their ecological range, with no cooler, wetter refuges available. Already experiencing reduced snow depth, earlier snow melt, increased summer temperatures and elevated CO_2, biodiversity within the Australian Alps has been identified as critically vulnerable under climate change. Today, we face growing pressure to manage and conserve native alpine plant species and communities.

Plant persistence will rely on continued seed germination success

The early stages of a plant's life cycle play a vital role in maintaining plant populations. However, high mountains are climatically extreme environments where low temperatures and short growing seasons often lead to annual fluctuations in seed production and quality. These conditions are likely to have favoured the evolution of mechanisms to ensure that alpine seed germination occurs not only in suitable microhabitats but also at optimal times of the year for onward seedling growth. In the Australian Alps, a significant proportion of plant species regenerate via seed, and their persistence, recovery from disturbance and ability to shift ranges in the future will depend on continued recruitment success.

Temperature is a primary factor in stimulating seed germination and regulating changes in seed dormancy status. Therefore determining when seeds germinate *in situ* would reveal the potential consequences of increased temperatures and extended growing seasons on the resilience of alpine plants and plant communities. Despite this, very little is known about the regeneration of Australian alpine flora. In addition, management and restoration efforts in the Australian Alps to date have lacked a sound understanding of alpine reproductive ecology. Much of the work with seeds and seedlings has been trial and error, lacking science-based decision making and ultimately leading to the misdirection of funds (R. Good, *pers comm*.). Clearly, we require solid knowledge of current regeneration strategies at the species level, in order to predict species responses *in situ*, and improve conservation outcomes. The call to 'boost seed effectiveness' and 'get smarter with seed' applies strongly to alpine restoration and management.

Diverse germination strategies currently maximise success

We have investigated the germination requirements of more than 25% of species currently growing above the treeline in Kosciuszko National Park, the majority of which had previously unknown germination requirements. By moving freshly harvested seeds through a series of incubator temperature regimes designed to mimic seasonal shifts that dispersed seeds would experience in the field, we have uncovered a range of different strategies, many of them highly conservative/cautionary, which suggest ways in which species optimise long term germination and establishment success.

Australian alpine seeds are dispersed in late summer/autumn, after which immediate, rapid and synchronous germination appears to be the regeneration strategy of some Asteraceae, Poaceae, Caryophyllaceae, Juncaceae and Plantaginaceae species. Such an opportunistic 'all-or-nothing' approach to germination suggests that seeds are non-dormant at dispersal and may maximise what remains of the short growing season by establishing before the onset of cold temperatures and snow.

In contrast, seed dormancy mechanisms appear to be prevalent, acting to delay/postpone/slow the rate of germination of many other species, thus conferring risk-averse regeneration strategies. The most common germination pattern suggested that, despite seed dispersal in summer, germination is postponed until during or following winter. Conservative germination strategies would be of great benefit in alpine environments where not every growing season can be relied upon as favourable for subsequent seedling establishment. In addition, timing germination for the onset of spring would enable seedlings to optimise the short growing season. Results for *Aciphylla* and *Oreomyrrhis* (Apiaceae) seeds suggest that germination occurs *during* winter, under the snow, and is controlled by both physiological and morphological dormancy mechanisms. Indeed, alpine seedlings require little resistance to frost since winter snow cover provides insulation from freezing temperatures.

Lastly, results suggest that germination phenology in response to temperature not only varies between species, but also between populations of the same species. Such within-species variation could profoundly influence species' responses and adaptation to environmental change (Bolnick *et al*., 2011).

Soil warming decreases germination from the alpine soil seed bank

In addition, we carried out the first assessment of the impact of soil warming on germination from the persistent alpine soil seed bank. Contrary to expectations, soil warming lead to reduced overall germination from the soil seed bank. However, germination response to soil temperature was species specific such that total species richness actually increased with soil warming. We further explored the system by assessing the prevalence of seed dormancy and germination response to soil disturbance, the frequency of which is predicted to increase under climate change. Seeds of a significant proportion of species demonstrated that dormancy mechanisms and germination are intrinsically linked to soil disturbance. In addition, we found no evidence of subalpine species and little evidence of exotic weed species in the soil, suggesting that, at least at present, the soil seed bank does not facilitate their invasion of the alpine zone.

Oreomyrrhis eriopoda *(Apiaceae) seeds at the point of natural dispersal in the Australian Alps. Photo: Gemma Hoyle*

Results suggest that predicted soil warming will decrease germination from the alpine soil seed bank but may help maintain local species diversity (Hoyle *et al*., 2013).

Implications for alpine management in the future

How might these insights into seed germination and dormancy support alpine restoration in the future? Regarding alpine seed storage and *ex situ* germination for propagation and planting:

- can use a diverse range of species;
- many species require no pre-treatments for germination;
- simple stratification treatments facilitate more immediate and synchronous germination of many species; and
- seed banking (dry storage at -20°C), is unlikely to alter germination potential or requirements.

Regarding the use of alpine seeds *in situ*:

- for many species there appears to be no critical window for sowing, however, seed characteristics such as specific germination requirements and dormancy mean that seedlings may not emerge for months or even years;
- seeds of many species are capable of becoming incorporated into the persistent soil seed bank and contributing to revegetation in the future e.g. post-disturbance;
- the soil seed bank, and the species richness therein, has the potential to help maintain local species diversity, support species range shift and moderate species dominance; and
- certain species appear better suited to germination under a future, warmer alpine climate (Hoyle *et al*., 2013).

Research moving forward

This work raises important questions regarding the effects of predicted changes in air and soil temperature upon alpine germination and dormancy traits and particularly upon variation between and within species in these traits. In addition to species for which germination requirements remain elusive, long-term vegetation surveys may help us target research towards species already experiencing recruitment limitations associated with climate change. Lastly, identifying within-species variation in seed germination and dormancy traits may support more precise forecasting of species' vulnerability to climate change.

This research forms part of an ARC Linkage Project that is currently investigating Australian alpine reproductive ecology, focusing on the key demographic stages of seeds and seedlings. Work is funded by the Australian Research Council, the Australian National Botanic Gardens and the Friends of the ANBG, with support from NSW Parks.

References

Bolnick, D.I., Amarasekare, P., *et al*. (2011). Why intraspecific trait variation matters in community ecology. *Trends in Ecology & Evolution* 26: 183-192.

Hennessy, K., Whetton, P., Smith, I., Bathols, J., Hutchinson, M., Sharples, J. (2003). *The impact of climate change on snow conditions in mainland Australia*. Aspendale VIC, CSIRO Publishing, Australia.

Hoyle, G.L., Venn, S.E., Steadman, K.J., Good, R.B., McAuliffe, E.J., Williams, E.R., Nicotra, A.B. (2013) Soil warming increases plant species richness but decreases germination from the alpine soil seed bank. *Global Change Biology* doi: 10.1111/gcb.12135.

Kullman, L. (2004). The changing face of the alpine world. *Global Change Newsletter* 57: 12-14.

Aciphylla glacialis *(Apiaceae), a dioecious perennial shrub endemic to the Australian alpine region. Photo: Gemma Hoyle*

---

21 years of seed conservation in the WA Department of Environment and Conservation: achievements and future directions

Anne Cochrane and Andrew Crawford

Science Division, Department of Environment and Conservation, Perth,, Western Australia.
Email: anne.cochrane@dec.wa.gov.au

Introduction

South West Western Australia has a rich endemic flora that faces a number of threats including habitat fragmentation, changed hydrology, introduced pests and diseases, and climate change. The threats facing this biodiversity hotspot are increasing in type, severity and scale, demonstrated by the rising numbers of species threatened with extinction. In particular, the root-rot pathogen *Phytophthora cinnamomi* is a biological disaster that threatens the survival of many of the region's most unique plants.

To combat the erosion of genetic diversity of Western Australia's native flora the Department of Conservation and Land Management (now Department of Environment and Conservation - DEC) secured Commonwealth government funding in 1992 to establish a seed bank for species susceptible to *Phytophthora* dieback and aerial canker. With this funding, the Threatened Flora Seed Centre (TFSC) was established. Standard seed bank conditions (low temperature (-20^{o}C) and low moisture content (~5%rh)) were employed to provide the most appropriate and cost-effective conditions for the storage of seed from the large range of orthodox (desiccation tolerant) species in Western Australia impacted by the disease.

Targeted species conservation

The aim of the TFSC was to collect and conserve seeds that represented the genetic diversity of the State's rare, threatened and poorly known flora. The seed bank began life in a transportable building at the Western Australian Herbarium in Perth. As the scale of activities of the Centre grew, so did the need for larger, more permanent facilities and in 2010 the new Western Australian Conservation Science Centre, incorporating the Western Australian Herbarium and Threatened Flora Seed Centre, was finally completed.

Initially the focus of the collecting activities of the TFSC was on species threatened by *Phytophthora* dieback disease and aerial canker, but later broadened to include those species most at risk in the wild, including species with low plant numbers, few populations or limited geographic range. Although in situ conservation is the primary focus of threatened species recovery actions, this may in itself be insufficient to ensure a species survival. In many cases where the habitat of threatened species is in immediate danger of destruction, and where on ground actions cannot guarantee species survival, the collection and maintenance of plant material from the wild becomes a necessity, acting as insurance. Banked seeds are available irrespective of season enabling their use whenever required.

Helping on ground conservation through seed use

For some West Australian species, dramatic declines in plant numbers and ongoing *in situ* threats have necessitated the translocation of material to new sites. Currently, DEC's seed collections support one of the world's largest and most diverse threatened species translocation programs, incorporating over 60 species across 85 sites.

In addition to species translocations, seeds have also been used in research providing information to assist on-ground conservation and management. Conservation geneticists have demonstrated just how important seed banking is in saving plant genetic diversity for future generations: seeds secured from now-extinct populations of the critically endangered *Banksia brownii* (Proteaceae) appear to be genetically distinct from plants in current extant populations. Banked seeds from these extinct populations have now been used to bolster genetic diversity of newly created populations. Banked seeds have also been used in studies aimed at determining the susceptibility of species to *Phytophthora* dieback disease; seedlings generated through routine germination testing have been used to test the susceptibility of 583 species to this virulent pathogen.

Partnerships

Over the past 21 years the Centre has been involved in many local, national and international partnerships that have contributed to its achievements. Since 2001, the Centre has been a participant in the Millennium Seed Bank Project (MSBP), an international seed conservation partnership managed by the Royal Botanic Gardens, Kew, UK. The aim of this project was to conserve 10% of the world's dryland flora, as seed, by 2010. Through its participation in this project the Centre was able to broaden the range of species targeted from just endangered species, to encompass all species of conservation significance including poorly known species. Collections made for this project are duplicated at the Millennium Seed Bank as a safeguard against damage or loss of the collections housed at the TFSC.

Endangered Verticordia in safe hands. Photo: Anne Cochrane

During this time, other seed banks in Australia entered into the partnership coalescing firstly into the Australian Seed Conservation and Research network (AuSCaR), and later into the Australian Seed Bank Partnership (ASBP), a cohesive union of Australian seed banking partners and associates. The Australian Network for Plant Conservation (ANPC) is one such associate member, and for many years the Threatened Flora Seed Centre has been an active member of the ANPC contributing to *Plant Germplasm Conservation in Australia: Strategies and guidelines for developing, managing and utilising ex situ collections* (1996) and the guidelines update in 2009.

The achievements

The Threatened Flora Seed Centre has made considerable inroads into the collection and conservation of the State's rare, threatened and priority flora. A summary of some of the major achievements of the past 21 years include:

- comprehensive collections of good quality, genetically diverse seed (collections from 75% of threatened species have been banked and 10% of these used in translocation; in addition, collections from 25% of Western Australia's poorly known species have also been banked)
- collections banked from currently extinct wild populations
- effective germination / propagation protocols for many species previously unknown
- new populations and species range extensions discovered during seed collection work
- seed research that informs species management (e.g. disease research)
- raising awareness of seed conservation within the community.

Bree Phillips, DEC Conservation Officer, collecting seeds of the threatened Jacksonia velveta. Photo: Anne Cochrane

Threatened Flora Seed Centre staff in the facility's drying room. Photo: Anne Cochrane

The challenges

Seed conservation and sustainable utilisation of seed resources presents many challenges for the future. The large number of threatened species in WA (currently over 400) in addition to over 2000 poorly known species of conservation significance makes prioritising and collecting seed difficult. Accessing adequate quantities of seed is also not easy due to small population size and low fecundity of many threatened species. It has become clear that for many of these species harvest from the wild may not be sustainable and hence the need to establish seed production orchards from wild sourced seeds, so that additional seed resources can be acquired without further impacting on wild populations.

A further challenge is tackling seed germination issues for some families of the Western Australian flora. The inability to reliably produce plants from seed limits the effective use of this seed in species recovery.

Finally, although seed conservation is an effective and cost-efficient means of supporting species in the wild, sourcing the funding required for maintaining existing collections is often difficult. Ongoing commitment for collecting unrepresented species and improving the size and genetic diversity of species already in storage is also a challenge. Ultimately, we endeavour to be able to improve the conservation status of our most endangered species through our actions. We must strive to strengthen the commitment to plant conservation and to mobilise sufficient resources to give ourselves the best chance of minimising the loss of plant diversity for future generations.

Flora of Australia Online – a continental taxonomic resource for the future of Australian plant conservation

Helen Thompson and Greg Whitbread

Department of Sustainability, Environment, Water, Population and Communities. Email: helen.thompson@environment.gov.au

Introduction

The Australian Biological Resources Study (ABRS) is a program of the Department of Sustainability, Environment, Water, Population and Communities. ABRS documents at a national level, the plants and animals that occur in Australia. ABRS facilitates, for the national view, the collection, description and classification of Australia's plants and animals. The taxonomic work is done by botanists and zoologists in the scientific community mainly working in herbaria, museums and universities. ABRS documents and collates, then disseminates the information to the public by publishing species information on Australia's plants and animals.

The *Flora of Australia* book series is the largest series on plants produced by ABRS and has formed the basis for the *Flora of Australia Online* database. The online information is currently derived solely from the published *Flora of Australia* books.

The information needed to produce a Flora

In order to write a *Flora* treatment (at State, Territory, regional or National level) you need to know what plants occur in your area, and what they are called.

The first step in producing the *Flora of Australia* was compilation of all plant names used in the Australian literature—this was done through the *Australian Plant Name Index* (APNI) project. For the *Flora of Australia*, botanists are required to account for every plant name in APNI, and to make decisions as to which names are accepted, and which are synonyms of the correct name.

To publish a new plant name you must define it and publish a description of the plant. As new names are published, they are added to APNI to maintain its currency. APNI is the main source of plant names for Australia, and has contributed greatly to our ability to document and subsequently understand and manage our plant species.

Online synergies—APNI and the *Flora of Australia Online*

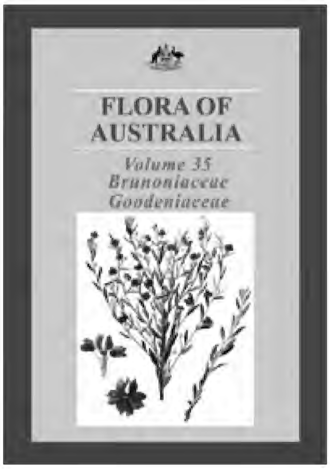
APNI uses references to create a view of how a plant name has been used over time. Each time a name is used in a publication it represents a unique ‘taxon concept’. The *Flora of Australia* is usually just one of the publications listed for a species in APNI. APNI reports the opinions of others, but does not make any taxonomic decisions.

The taxonomic decisions as to which species are accepted are made by botanists and recorded in APNI as part of the *Australian Plant Census* (APC) project, which is overseen by the Council of Heads of Australasian Herbaria (CHAH). A green tick currently indicates the accepted APC taxon concept on the APNI web page. The APC web page gives a neater view of accepted plant names and their synonyms, but it is not a separate database.

The National Species Lists project

Three years ago ABRS, CHAH and the Australian National Botanic Gardens (ANBG) received funding for the National Species Lists (NSL) infrastructure project for delivery of species information. The NSL was initially funded by the Atlas of Living Australia program. The Atlas requires consensus species names as an anchor for delivery of its web information. The *Australian Plant Name Index* (for plants) and the *Australian Faunal Directory* (for animals) were chosen as the primary species lists that the Atlas uses.

Further development of the NSL will enable the *Flora of Australia Online* to directly use the APC taxon concepts and the APNI nomenclature. This will reduce duplication of data and effort. The main focus for the *Flora of Australia Online* in the future will be delivery of species profile information. The profile information includes the plant description, habitat, distribution, notes on conservation, aboriginal uses etc.—it is essentially all of the information from a flora treatment excluding the name, author and publication details.



Flora of Australia is produced by Australian Biological Resources Study (ABRS), a program of the Department of Sustainability, Environment, Water, Population and Communities. The Flora is available both as a book series and as an online database.

The NSL project will also enable linkages with other data sources such as the *Australian Plant Image Index* (APII) and the Australia’s Virtual Herbarium (AVH) (for dynamic distribution maps). It will enable data exchange with other institutions (e.g. exchange of flora profiles between *Flora of Australia Online* and Western Australia’s *FloraBase*, and delivery of species information to the Atlas of Living Australia).

The Global Types Initiative (GTI under the Global Plants Initiative) aims to digitise all vascular plant types and make them available online. The Australian herbaria have received funding through the Andrew W. Mellon Foundation to purchase scanners and camera equipment, and to employ staff to digitise their type specimens. The images from this project should also be accessible through the NSL. The GTI will improve online access to type information which will greatly assist botanists in identifying which plants belong to a name.

NSL will provide additional functionality for *Flora of Australia Online*

The core of the NSL for plants is the nomenclatural data from APNI and the taxonomic decisions made through the *Australian Plant Census* process. Together these form the starting point for all value-added species data (maps, images, profile data, recovery plans etc.). Development of the NSL is underway, but completion of the project is resource-dependent.

The NSL aims to enable the *Flora of Australia Online* to dynamically use:

- APNI for nomenclatural information
- APC for taxonomic status
- APII for images (including type specimen images)
- AVH for dynamic maps.

The NSL aims to provide:

- Online editing interfaces for APNI and the *Flora of Australia Online*
- Easier updating of the data and maintenance of currency
- Data exchange with other institutions (e.g. exchange of flora profiles between *Flora of Australia Online* and *FloraBase*; delivery of species names to the Atlas of Living Australia).

Readily available, reliable and comprehensive name information is required for land management, conservation, biosecurity, trade etc. The National Species Lists project is a step towards providing such an integrated data resource online at a national level.

Case study: Identification of *Acacia lanuginophylla*

The NSL will enable better access to online plant information such as the data in APNI, *Flora of Australia Online*, GTI and APII. The NSL should provide a useful data interface for many users, including those who need to identify plants for use in conservation and recovery plans.

In a Western Australian Department of Conservation Recovery Plan, Bruce Maslin states that *Acacia lanuginophylla* is closely related to *Acacia cassicula.* For effective management and conservation of species the manager needs to know what *Acacia lanuginophylla* actually is.

To ensure the correct name is being used for a plant a botanist refers to the original type specimen data. Each published plant name will have a type or reference point. The type is an element, usually a herbarium specimen, on which a species name is based. This is made up of the original description of the plant, the collection records (such as collectors name, number and date of collection), the type statement indicating where the collection was made, and the herbarium in which the type specimen is lodged. This information defines and limits what plants can belong to a name.

Apart from the original description of the plant there may be later detailed botanical descriptions, and there may be diagnostic descriptions that give a simpler view of how plants differ from their close relatives. For instance, in the Recovery Plan, Bruce Maslin states that '*Acacia lanuginophylla* is distinguished by the dense, woolly hair that covers most parts of the plant including the pods'.

The preserved type specimen usually represents the original specimen, or a duplicate of the first collection. In the case of Australian species, these specimens are often held in overseas herbaria. Botanists have relied on the type collection and related information to make decisions about names. Now this data is being made more readily available online, enabling better access to species information required for correct plant identification and consequently for effective plant conservation.

Web addresses

Flora of Australia Online:
http://www.environment.gov.au/biodiversity/abrs/online-resources/flora/main/

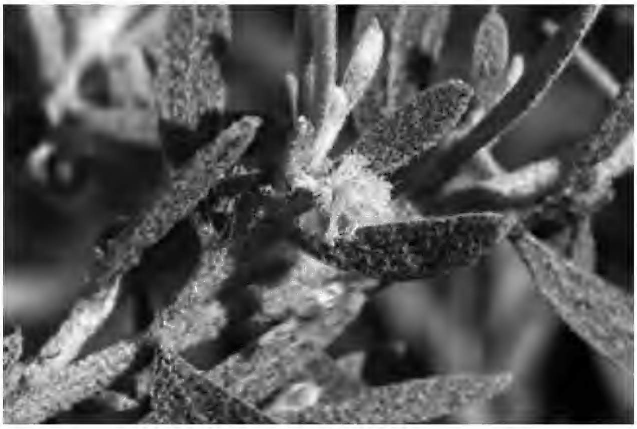
Australian Plant Name Index:
http://www.anbg.gov.au/cpbr/databases/apni-search-full.html

Australian Plant Census:
http://www.anbg.gov.au/chah/apc/

Australian Plant Image Index:
http://www.anbg.gov.au/cgi-bin/apni

Australasia's Virtual Herbarium:
http://avh.ala.org.au/

Atlas of Living Australia:
http://www.ala.org.au/



Close up of Acacia lanuginophylla *flower and leaves showing the dense, woolly hair that covers most parts of the plant. Photo: M. Fagg*

Enhancing and restoring diverse grasslands and grassy woodlands: are we there yet?

Paul Gibson-Roy

Greening Australia. Email: pgibson-roy@greeningaustralia.org.au

Temperate native grasslands and grassy woodlands are among Australia's most threatened plant communities. Australia's 2011 State of the Environment Biodiversity 'score-card' noted; "*despite promising investment by all jurisdictions in addressing the main pressures on biodiversity, pressures are not being substantially reduced, nor is the decline in biodiversity being arrested or reversed*". Despite this worrying observation, many restorationists continue to seek ways to restore these communities (albeit at small scales) to a condition that is similar to that speculated as their pre-European state.

Fire management

While not universally accepted, Gammage (2012) presents a range of historical evidence he interprets to indicate grasslands and grassy woodlands were much more widely occurring at the time of European settlement than currently recognised. Gammage proposes that the composition/structure of Australian vegetation was intimately manipulated and shaped by Aboriginal peoples to a hereto unrecognised degree through prolonged and sophisticated use of fire management, primarily to facilitate reliable food resources and for cultural and spiritual reasons. Following the gradual cessation of long-term and micro-managed burning practices post 1788, coupled with the dramatic increase in human population, infrastructure and the imposition of European agriculture, the Aboriginal-shaped landscape was significantly and permanently altered, impacting on the frequency, complexity, condition and extent of herbaceous communities. Indeed, Gammage suggests that many current areas of dense bushland protected in parks and reserves are not, as many think, examples of 'natural' pre-European vegetation at all, but rather locations that were once managed and maintained as open grassy communities by indigenous Australians.

Restoration challenges

While the distribution and composition of grasslands and grassy woodlands remains contested, current barriers to the existence and recovery of these systems are much more tangible and include; fragmentation, scarcity of source populations, lack of seed resources, intense competition from exotics, and unsuitable disturbance or management regimes.

In agricultural locations, recolonisation (or reconstruction) is also impeded where soil nutrients have been elevated (primarily through superphosphate fertilisation) which favours many of the dominating exotic flora (Dorrough and Scroggie 2008). Thus, in certain situations where native vegetation remains intact and not ultilised for intensive agriculture, alterations to management/disturbance regimes and frequencies may facilitate a return of groundlayer complexity and structure. In situations where native vegetation has been replaced or significantly altered by farming practices, more intensive ecological reconstruction is likely to be the most effective means of reinstating native herbaceous communities (Gibson-Roy 2010).

For some time restoration in Australia has been reasonably successful in revegetating woodlands with native trees and shrubs, but there has been some reluctance to include grasses and especially forbs into plantings. A primary obstacle to the use of herbaceous layers was, and remains, a lack of reliable seed supplies (Mortlock 2000). To a lesser extent the reluctance has also been because the fruits and seeds of many herbaceous species do not flow well through traditional agricultural seeders, which form the basis of most restoration machinery. Encouragingly, in the last decade and a half this reluctance has diminished with an increased focus on direct-seeding native grasses for pasture fodder and soil stabilisation. Many such programs were initiated through or supported by rural landholders involved with Stipa, the Australian Native Grass Association (formed in 1997). Stipa and many others helped to raise the profile of native perennial grasses in rural Australia. More recently, there has been a move to including broader ranges of herbaceous species in restoration programs, where this was once thought unfeasible under field conditions.

One of the early programs to test the efficacy of this approach at field scales was the Victorian Grassy Groundcover Research Project (GGRP) initiated by Greening Australia and Melbourne University. The GGRP provided clear evidence that functionally complex, species-rich herbaceous communities could be established on bare-field sites by direct seeding. Early GGRP sites have persisted and maintained their integrity (given appropriate management), which is also a significant outcome. In addition, the GGRP highlighted the utility and importance of seed production methods in securing appropriate seed resources for community-scale restoration.

Development of restoration and seed sector

There is now an increasing confidence and momentum in the undertaking of programs that seek to restore

An example of a reconstructed grassland at the Werribee Open Range Zoo, undertaken in partnership with Greening Australia's Victorian Grassy Groundcover Research Project and the Zoo. The grassland was established to provide habitat for an Eastern Barred Bandicoot breeding program, but is now also recognised for the beauty and uniqueness of the native grasses and wildflowers. Photo: Paul Gibson-Roy

An example of a dedicated seed production operation, run by Flora Victoria, suppling high quality seed and restoration services focusing on the Basalt Plains flora. Photo: Chris Findlay

groundlayer communities, in part due to a prolonged dissemination of ideas and experiences throughout the NRM sector. In many areas of south eastern Australia there are now projects being planned or implemented to conserve, enhance or reconstruct grasslands and grassy woodlands. Larger-scale projects have been initiated by several organisations including the Torrens River Land Care network (SA), the City of Salisbury (SA), Greening Australia (NSW, ACT and Vic), the National Botanical Gardens and the Myer/Kosciusko-2-Coast program. These are often aided by know-how and equipment from an increasing number of private restoration businesses that include; Cumberland Plain Seed (NSW), Flora Victoria (Vic), Grassland Flora (Vic), Natural Capital (NSW), and Zwierson Restoration Services (SA).

This increase in onground projects has been to a large degree aided by a slow but continued development of the seed sector. Today, there are a number of seed production businesses run privately or through NRM agencies and NGOs across Australia. These seek to help meet market demand for native seed using systematic techniques. Seed Production Areas (SPAs) are doubly important in that they help to lessen the impact of unchecked seed harvest on remnant populations. It is almost certain that SPAs hold the key to securing reliable quantities of quality seed from a wide range of both common and threatened species.

Among those in this important and emerging sector are Cumberland Plain Seeds (NSW), the City of Salisbury (SA), Euroa Arboretum (Vic), Flora Victoria (Vic), Grassland Flora (Vic), Greening Australia (ACT/NSW/Vic), Ko-Warra Seeds (Vic), National Botanic Gardens (ACT), Native Seeds (NSW/Vic).

Have we succeeded?

Are we there yet? No, not in reality. Unlike in some parts of the UK, Europe and North America we do not have a large and well-structured seed industry supported by an active and valued restoration sector. Sadly in this country, while much lip service is paid to protecting and/or restoring the environment, the comparatively minor support it receives from public and private purses suggests that in reality it falls well down the ladder of importance for the 'powers that be'. This lack of significant financial drivers to support ecological restoration (and therefore the associated industry) remains a critical and vexing reality for many in the sector. However, it should be recognised that some progress has been made in recent times with many of the aforementioned projects being funded through Federal and State programs (Biodiversity Fund, Caring For Our Country), market-based programs (Biodiversity Offsets, Carbon Farming) or to meet regulatory requirements (road/rail, energy and resource sectors). While back at the coal face, the restoration of complex herbaceous communities is nowadays (happily) viewed as technically achievable. This is in itself a notable achievement, made possible through the efforts of a great number of remarkable and largely unsung people over many decades. With this confidence comes a greater appetite for achievement. Let us hope that these small but important advances in our understanding of grasslands and grassy woodlands also contributes to influencing our society to better balance the needs and wants of the human species, with those of the countless others with whom we share this wonderful country.

References

Gammage, B. (2012). The Biggest Estate on Earth – how aborigines made Australia. Allen & Unwin. Sydney.

Dorrough, J., Scroggie, M. (2008). Plant responses to agricultural intensification. *Journal of Applied Ecology* 45, 1274–1283.

Gibson-Roy, P., Moore, G., Delpratt, J., Gardner, J. (2010). Expanding horizons for herbaceous ecosystem restoration: the Grassy Groundcover Restoration Project. *Ecological Management & Restoration*. Volume 11, Issue 3, pages 176–186.

Mortlock, W. (2000). Local seed for revegetation Where will all that seed come from? *Ecological Management & Restoration.* Volume 1, Issue 2, pages 93–101.

Report from New Zealand Plant Conservation Network

Kerry Gillbanks

Auckland Council, NZ. Email: kerry.gillbanks@aucklandcouncil.govt.nz

A new way of seed propagation

The Forest Lifeforce Restoration Trust has been successful in propagating the nationally critical *Clianthus maximus* seed by shooting them into soil from a shotgun at its property in the Maungataniwha Native Forest, in inland Hawkes Bay. Back in 1983 this area was being assessed as a potential addition to the Te Urewera National Park and a lone *C. maximus* was found growing nearby in the Waiau bluffs within the National Park. In 2008 a search was done to see if any more were growing. Another three plants were located. Following this discovery funding was provided for enclosures to be made within the Maungataniwha Native Forest and the Department of Conservation provided consent for the collection of seed from the wild plants. Currently there are 150 *C. maximus* growing within the enclosures creating a 'seed orchard' – providing bulk seed for their new project. Re-loaded shotgun shells were packed with shotgun pellets, a pulp medium and the *C. maximus* seed. The shells were discharged into the soil from a range of 20 metres. The goal is to shoot them into areas from a helicopter that is inaccessible to humans as well as to browsers like rabbits and hares. For more information visit www.forestlifeforce.org.nz.

New Zealand's favourite plant for 2012

At the end of every year the Network opens up voting for New Zealand's favourite plant. Kauri (*Agathis australis*) was voted the winner for 2012. Comments from voters ranged from how the Kauri played an important role in our history and culture, how it created a unique forest type and supports a diverse range of plants and animals and highlighting its current plight with Kauri dieback (*Phytophthora* taxon *Agathis* (PTA)). This year we invited voting for worst weed. Wandering Jew (*Tradescantia fluminensis*) was voted the worst. This species was brought to New Zealand from Brazil as an ornamental but is now found throughout the country due to it being able to reproduce from the smallest fragment and quickly smothers low-growing native plants.

Network/Website updates

'Are we there yet? 10 years of the Plant Conservation Network' is the theme for our conference being held in May. Check out our website for details on the different symposia, workshops and field trips.

The Networks online image library has passed the 24,000 images mark. The website now has 93.6% of the native vascular flora and 55% of the exotic vascular flora fully illustrated.

Visit www.nzpcn.org.nz for more information.

ANPC Workshops

Participants learning how to set up a flora monitoring plot at a recent ANPC workshop on Plant Identification for Grassy Ecosystems held in Canberra on 13 & 14 March, 2013. Other recent ANPC workshops include Translocation of Threatened Plants and Seed Use for Native Vegetation Restoration.

A report on these workshops, along with dates of future ANPC workshops will be included in the next issue of APC.

Upcoming conferences and workshops

NZPCN Conference 2013
Are we there yet? 10 years of the plant conservation network

23 –26 May 2013
Auckland, New Zealand

In conjunction with Auckland Botanical Society, Landcare Research Manaaki Whenua, the Department of Conservation and Auckland and Massey Universities, the next NZPCN Conference will be held in Auckland in May. This marks 10 years of the plant conservation network. For more information on the different symposia, workshops and field trips visit http://www.nzpcn.org.nz/page.aspx?nzpcn_events_conference_2013

Australian Native Plants Society 2013 Conference and Seminar

10–16 August 2013
Sunshine Coast, QLD

The Australian Native Plants Society is hosting its 2013 Conference and Seminar which will be held in late winter on Queensland's Sunshine Coast. The theme for the conference is *Diversity is in our Nature*. Associated with the Conference are several pre- and post-Conference tours. For further information visit http://asgap.org.au/whatson.html

17th NSW Biennial Weeds Conference

9-12th September 2013
Corowa, NSW

The Weeds Society of New South Wales Inc. will be holding its 17th NSW biennial weeds conference in Corowa, NSW. The theme of the conference is *Weeds have no boundaries!* For more information visit http://www.nswweedsconference2013.com/

22nd International Grasslands Congress

15 - 19 September 2013
Sydney, NSW

The overall Congress theme is revitalising grasslands to sustain our communities. The program will explore the current issues facing grasslands around the world and share the latest industry developments and solutions.

The proposed Congress program will be delivered in three main streams:

- Improving production efficiency to revitalise grasslands
- Improving grassland environment and resources
- Grassland people, rights, policies, practices and processes.

The Congress aims to present a program which is participative, innovative, stimulating, thought-provoking and enriching by offering networking and learning opportunities to new and experienced, Grassland scientists, Extension workers, Postgraduate students and some undergraduate students, Agri-business professionals, policy makers and leading livestock producers and farmers from all over the world. For more information visit http://www.igc2013.com/pages/destination-sydney.php

Queensland Landcare Conference

27-29 September 2013
Warwick, Queensland

Hosted by Condamine Headwaters Landcare Group, the 2013 Queensland Landcare Conference in Warwick will bring together land managers, policy workers, extension staff and researchers to explore healthy habitats and profitable production. The Conference program will include keynote presentations, a dedicated Junior Landcare component, interactive learning opportunities, field trips, lots of networking opportunities and an exhibition for landcare suppliers and partners.

More information will also be made available online at: http://headwaters.ddrlandcare.org/index.php?option=com_content&view=frontpage&Itemid=268.

2013 Government Sustainability Conference

7-8 October, 2013
Melbourne, Vic

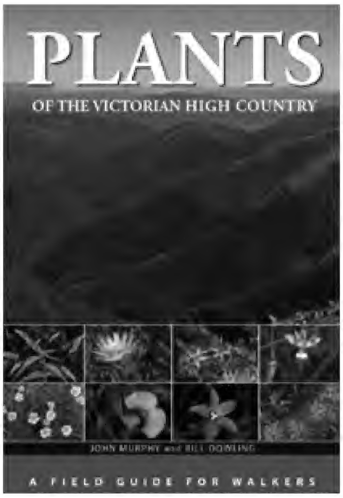
The 2013 Government Sustainability Conference will provide delegates from local, state and federal government authorities with comprehensive analysis and advice about how to embed environmentally sustainable policies and practices within their organisations and the communities they serve. This national conference will provide attendees with the means to network and discuss environmental best practice with officials from the nation's public sector sustainability leaders. The conference will also provide attendees with high-quality information and case studies that will assist them to address crucial environmental issues facing all levels of government.

For more information visit http://commstrat.cvent.com/events/government-sustainability-conference/event-summary-a598cde403bb4d85bd4de7bb58299793.aspx

Book reviews

Plants of the Victorian High Country a field guide for walkers

by John Murphy and Bill Dowling
CSIRO Publishing, August 2012
152 pages with colour photographs and line art
Paperback, ISBN: 9780643104631
Price: AU $29.95
Available from: www.publish.csiro.au


PLANTS
OF THE VICTORIAN HIGH COUNTRY
JOHN MURPHY and BILL DOWLING
A FIELD GUIDE FOR WALKERS

This book is written with the aim of providing a general reference for identifying plants of the high country of Victoria including species in the montane, sub-alpine and alpine zones. It is not a comprehensive book having only included 119 taxa of the "most common High Country plants." It is a general book that facilitates the identification of plants in the region being covered and by necessity only samples some large plant families. The diverse orchid family is represented by two genera and one species, and the Epacridaceae family has five species included; both and probably many other families presented have more species occurring in the area with less common species excluded. It appears that the authors have selected the species well while concentrating on species with easily observed charismatic flowers.

The book is published by CSIRO and the Australian Plants Society Victoria and the intended audience is broad, from people with little plant knowledge to well-informed amateurs and possibly professional botanists. It meets the goal of appealing to a broad audience through the introductory sections, structure of the book and the composition of each plant description.

The introductory sections include a section on how to use the book, an overview of the high country environment, and clear drawings of the common flower types encountered in the high country and covered in the book. These sections are short and to the point, a nice approach as the authors simply present the critical information necessary to understand the groups of plants that might be found and help identification of the plants through simple drawings with clear diagnostic characteristics of the flowers.

The plant descriptions are initially divided into five relevant groups based on life form and abundant families, i.e. herbs other than daisies, daisy herbs, low woody shrubs, tall shrubs and trees other than eucalypts and eucalypts. Each group begins with a simple key using technical but easily understood terms to help the reader determine the genus (and a page number) to consider. Within each group the plant families are presented alphabetically as are the individual species presented within each family. This structure will be appreciated by more knowledgeable readers but is also a gentle way for less knowledgeable readers to learn about plant families and genera, and their key characteristics. This structure and the keys are the strength of the book.

Each plant description includes a general introduction, usually a botanical description, followed by sections on the zone where they grow, descriptions of leaves and/or flowers with information on flowering times and sometimes seed pods. There is also usually one photograph used to illustrate each species. The descriptions are written with significant detail yet often don't provide enough specific details to differentiate between species well. The photographs are generally beautiful images and are well selected to present the flowers but don't necessarily provide good views of leaves or plant structures which in many cases are critical to plant identification. This is an inherent limitation when choosing one illustrative photo rather than using multiple photos or drawings.

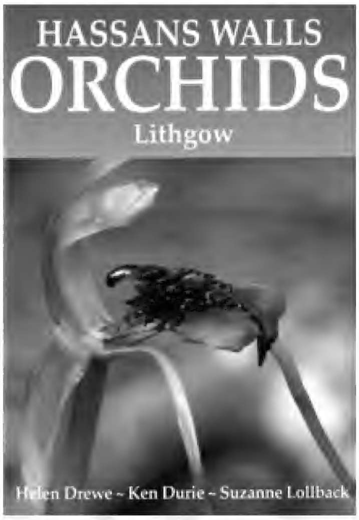
This book is a good addition to a naturalist's library as it provides resources to identify common plants in the high country within a framework that facilitates identification efforts. However, it is not a definitive plant identification book for the Victorian High country. It easily fits in a daypack or pocket and it would provide a reasonable reference on its own for common plants but for those wanting more comprehensive identification resources this book can only be part of the small library you might take to the high country if a wider view of the flora is wanted.

Lincoln Kern, Practical Ecology, Preston, Vic.

Book reviews (cont.)

Hassans Walls Orchids – Lithgow

by H. Drewe, K. Durie, S. Lollback
Lithgow & District Community Nursery
38 pages with colour photographs, paperback booklet.
ISBN 9780646579597
Price: AU$10.00
Available from: Lithgow & District Community Nursery,
PO Box 492, Lithgow NSW 2790;
or email h.drewe@bigpond.com



You don't know what you've got until you look! Who would have thought that the relatively small (770 ha) Hassans Walls Reserve, on the western edge of the Blue Mountains of NSW, would harbour a staggering 62 species of terrestrial orchids? Perched above Lithgow, with a substrate of sandstone and shale, the reserve has long been known as a 'good wildflower area', but the density of orchid species has only become apparent through diligent recording by these authors over a decade.

This booklet, well printed on good tough paper stock, is a photo-based field guide, with minimal text. The photos, nearly all of flowers only, are good quality. The scientific names used follow the recent genus-level splits made by David Jones (see his *Native Orchids of Australia*, New Holland Publishers, 2006), which have a particular impact in the species-rich alliances, such as *Caladenia* and *Pterostylis* among others (the reality of the species is mostly not debated, just the genera to which they are assigned). While many of the segregate genera are not accepted by all the nation's herbaria, they are gaining currency among many orchid enthusiasts. Sensibly, the authors of this booklet give both the 'Jones names' and those used under the more traditional classification.

The number of species covered make this a useful guide to orchids of the western Blue Mountains generally, although you have to wonder how many more unexpectedly rich patches – of orchids and other species – have yet to be documented. Booklets like this highlight the contribution to knowledge that can be made by organised local groups conducting sustained monitoring of their local areas.

Bob Makinson, Royal Botanic Gardens Sydney, NSW

Information resources and useful websites

ANPC now sharing plant conservation news on Facebook, Twitter, and Google +

The Australian Network for Plant Conservation has embraced social media in our efforts to promote and develop plant conservation. You'll now find us sharing plant conservation news on Facebook, Twitter, and Google +.

We're also sharing images from current and past ANPC activities on Flickr (http://www.flickr.com/photos/anpc/).

We'll continue to send out a summary of major news every 3-4 weeks via the ANPC News email newsletter. If you have plant conservation news you would like us to share please email your news to anpc@anpc.asn.au. Please include "For ANPC News" in the subject.

Glimpses into disappearing landscapes: nationally listed threatened ecological communities of the South West Region

http://swccnrm.org.au/work/biodiversity/glimpses-into-disappearing-landscapes/

South West Catchments Council, in partnership with the WA Department of Environment and Conservation has released a new publication Glimpses into disappearing landscapes. Nationally Listed Threatened Ecological Communities of the South West Region.

The South West Region is home to several amazing Threatened Ecological Communities – natural communities that exist here and nowhere else in the world. If we are to protect these special assets, we need to improve the awareness and understanding of the general community – and that means cutting out the scientific jargon. The book includes photos by professional photographer Tim Swallow which visually capture the uniqueness of each of the communities as well as easy to read and informative text to convey just how special these places really are.

Information resources and useful websites (cont.)

A free download is available from http://swccnrm.org.au/work/biodiversity/glimpses-into-disappearing-landscapes/. Limited hard copies are also available upon request. Please phone 9780 6193 or email lauren.lane@agric.wa.gov.au to request a copy.

Building capacity for plant conservation - the role of botanic gardens'

Special themed issue of BGjournal
Available from http://www.bgci.org/resources/bgjournal/

Many of the major issues facing society today are related to how we manage our natural resources. However, despite the importance of plant science in addressing such issues, many countries are seeing a decline in botanical capacity. Target 15 of the Global Strategy for Plant Conservation calls for the number of trained people working with appropriate facilities to be sufficient according to national needs to achieve the targets of the GSPC by 2020.

BGjournal is the worldwide journal of botanic garden conservation. The papers in this issue of BGjournal illustrate how, through the development of dynamic local and international partnerships, through both formal and informal training and education programmes, botanic gardens around the world are working to ensure that Target 15 is met.

National Atlas of Groundwater Dependent Ecosystems

http://www.bom.gov.au/water/groundwater/gde/

In many parts of Australia, there is increasing pressure on groundwater resources from activities including agriculture, mining, urban and commercial developments. While groundwater dependent ecosystems are vulnerable to such pressures, there is a knowledge gap in understanding how they should be managed.

The Groundwater Dependent Ecosystems Atlas aims to address the knowledge gap by creating the most complete inventory of the location and characteristics of groundwater dependent ecosystems in Australia.

It is developed to:

- collate existing information on groundwater dependent ecosystems
- identify the location and characteristics of groundwater dependent ecosystems that have not previously been identified
- provide a central, web-based portal to present the information.

Ground Dependent Ecosystem Risk Assessment Guidelines

NSW Department of Primary Industries, Office of Water

The NSW Department of Primary Industries (Office of Water) has developed new risk assessment guidelines to manage land and water use activities that can affect groundwater dependent ecosystems. These are available at http://www.water.nsw.gov.au/Water-management/Water-availability/Risk-assessment/Groundwater-dependent-ecosystems/Risk-assessment-guidelines-for-groundwater-dependent-ecosystems

Census of the Vascular Plants, Hornworts, Liverworts and Slime Moulds of the ACT

http://www.anbg.gov.au/cpbr/ACT-census-2012/

The Census of the Vascular Plants, Hornworts, Liverworts and Slime Moulds of the Australian Capital Territory lists the scientific names of the native and naturalised vascular plants, hornworts, liverworts and slime moulds known to occur in the Australian Capital Territory. All records are based on herbarium specimens housed in the Australian National Herbarium.

Seeds of South Australia online

http://saseedbank.com.au/splash.html

The South Australian Seed Conservation Centre has developed an online resource about seeds of South Australia. This online resource provides a source of seed images for South Australian native plants, a seed identification key and species fact sheets containing seed biology information as it becomes available.

Soil information available through SoilMapp

http://www.csiro.au/Organisation-Structure/Flagships/Sustainable-Agriculture-Flagship/SoilMapp-for-iPad.aspx

Australia's national soil databases can now be accessed in real time online through a new iPad app called SoilMapp. The app provides open access to the best and most up-to-date information for soils across the country within a matter of seconds. The underlying databases contain information on approximately 85 000 samples from nearly 15 000 locations, some dating back to the 1950s. Information available includes soil depth, acidity, salinity, soil carbon, soil water holding capacity and other attributes.

The app has been developed by the Australian Collaborative Land Evaluation Program (ACLEP) and CSIRO, with funding from the Grains Research and Development

Information resources and useful websites (cont.)

Corporation (GRDC). The app taps into soil information from the Australian Soil Resource Information System (ASRIS) and APSoil, the database behind the farming systems model, the Agricultural Production Systems SIMulator (APSIM), which is used worldwide.

Find out more about SoilMapp for ipad at http://www.csiro.au/Organisation-Structure/Flagships/Sustainable-Agriculture-Flagship/SoilMapp-for-iPad.aspx, or email asris@csiro.au.

Integrated conservation of tree species by botanic gardens – a reference manual

Compiled by S Oldfield and A.C. Newton
Published by Botanic Gardens Conservation International, Richmond, UK
http://www.bgci.org/resources/news/0994/

This manual is designed to guide and stimulate action by botanic gardens to save threatened trees from extinction. Pertinent thinking about plant conservation and how to apply this in the specific case of trees is presented, along with step-by-step guidelines for initiating tree conservation work. The conservation issues discussed in the manual are illustrated by a series of practical case studies, which provide further valuable information to guide activities on-the-ground. Hard copies of the manual have been sent to all Botanic Gardens Conservation International (BGCI) members. Additional copies are available free-of-charge and can be requested from BGCI. Free download from http://www.bgci.org/resources/news/0994/ for free hardcopy email info@bgci.org

Queensland Herbarium (Brisbane Botanic Gardens): changes to contact details

The website URL for the Queensland Herbarium, and email address formula for its staff, have changed:

Web: http://www.qld.gov.au/environment/plants-animals/herbarium

General enquiries: Queensland.Herbarium@science.dsitia.qld.gov.au

New email format for staff: firstname.lastname@science.dsitia.qld.gov.au

Postal address and phone/fax numbers remain the same:

Queensland Herbarium, Brisbane Botanic Gardens,
Mt Coot-tha Road, Toowong Qld 4066 Australia

Ph: +61 (7) 3896 9326
Fax: +61 (7) 3896 9624

National Biodiversity Investment Prospectus

Department of Sustainability, Environment, Water, Population and Communities
www.environment.gov.au/prospectus

The first national biodiversity investment prospectus has been released by the Commonwealth Government. The prospectus, *One Land - Many Stories: Prospectus of Investment 2013-14*, sets out the framework for government investment in biodiversity conservation under programs within the Land Sector Package.

The prospectus provides information in one place about the range of grant programs available so that applicants can assess the program/s that are the most appropriate to support their conservation and natural resource management activities. This Prospectus is supported by a series of grants program guidelines which outline the specific requirements of each program and provide information to applicants about how to apply.

EPBC Act environmental offsets policy

Department of Sustainability, Environment, Water, Population and Communities
http://www.environment.gov.au/epbc/publications/environmental-offsets-policy.html

The Commonwealth Department of Sustainability, Environment, Water, Population and Communities has developed an offsets policy, replacing the draft policy (2007). It provides a consistent method to assess offsets for environmental impacts on matters of national environmental significance listed under the Environment Protection and Biodiversity Conservation Act 1999. It aims to improve environmental outcomes through the consistent application of best practice offset principles, provide more certainty and transparency, and encourage advanced planning of offsets. Accompanying this policy is an offsets assessment guide which provides a tool for the department and the proponent to assess the suitability of the offsets.

Information resources and useful websites (cont.)

National Wildlife Corridors Plan

Department of Sustainability, Environment, Water,
Population and Communities
http://www.environment.gov.au/biodiversity/wildlife-corridors/index.html

The Commonwealth Government has released the National Wildlife Corridors Plan, which aims to improve resilience for the environment by connecting protected areas, reconnecting the Australian landscape through a network of wildlife corridors across Australia.

The Plan outlines a process for communities to identify and nominate areas they believe will contribute to a national network of wildlife corridors. An area that meets the criteria and is declared as a National Wildlife Corridor may be eligible for priority funding under a range of Australian Government funding programs.

The National Wildlife Corridors Plan Advisory Group undertook consultation on the draft plan with stakeholders across the community, including regional natural resource management organisations, environment groups, local and State governments, scientists, Aboriginal and Torres Strait Islander people, tourism organisations, planning organisations and agricultural and mining peak bodies.

The plan will help guide future government investment through a range of initiatives, such as Caring for our Country and the Biodiversity Fund. The Clean Energy Future Plan's Land Sector Carbon and Biodiversity Board will provide advice to the Environment Minister on wildlife corridors within the landscape.

Managing Invasive Native Scrub

Catchment Management Authority, Central West
http://cw.cma.nsw.gov.au/OurNaturalAssets/managinginvasivenativescrub.html

The phenomenon of Invasive Native Scrub, the thickening and encroaching native trees and shrubs, is a serious issue in the central-west and western regions of NSW (and rangelands elsewhere) and can impact on habitats, wider landscape health, communities and farming operations.

This management guide provides a synthesis of the results of scientific research and practical knowledge gained by many landholders who have been managing invasive native shrubs. It is a comprehensive reference for strategic management and outlines the basic management principles, what management techniques work under difference circumstances to manage invasive native scrub to rehabilitate native pastures & open woodlands.

Communities for Communities

Department of Sustainability, Environment, Water,
Population and Communities
http://www.environment.gov.au/biodiversity/threatened/publications/communities-newsletter/index.html

Issue 16 of Communities for Communities, includes the listing of five new ecological communities under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 as well as information about key workshops held last year, including the National Threatened Ecological Communities Strategic Workshop and more.

Restoration Ecology: The New Frontier, 2nd Edition

Edited by Jelte van Andel and James Aronson
Wiley-Blackwell, April 2012, 400 pages
Paperback, ISBN: 9781444336351; AU $87.95

Since 2006, when the first edition of this book appeared, major advances have taken place in restoration science and in the practice of ecological restoration. Both are now accepted as key components of the increasingly urgent search for sustainability at global, national, and community levels – hence the phrase 'New Frontier' in the title. While the first edition focused on ecosystems and landscapes in Europe, this new edition covers biomes and contexts all over the world. Several new chapters deal with broad issues such as biological invasions, climate change, and agricultural land abandonment as they relate to restoration science and ecological restoration. Case studies are included from Australia, North America, and the tropics.

This is an accessible textbook for senior undergraduate and graduate level students, and early career scientists. The book also provides a solid scientific background for managers, volunteers, and mid-career professionals involved in the practice of ecological restoration.

Available as an eBook, Hardcover or paperback from http://au.wiley.com/WileyCDA/WileyTitle/productCd-1444336363.html.

Research round up

Compiled by Kirsten Cowley, Centre for Plant Biodiversity Research, Canberra.
Email: Kirsten.Cowley @csiro.au

Special Issue: **Savanna Burning** *Austral Ecology* 37(6) (2012) whole issue

Ansong, M. & Pickering, C. (2013). **Long-distance dispersal of Black Spear Grass (*Heteropogon contortus*) seed on socks and trouser legs by walkers in Kakadu National Park.** *Ecological Management & Restoration* 14(1). DOI:10.1111/emr.12021

Bear, J.L. Giljohann, K.M., Cousens, R.D. & Williams, N.S.G. (2012). **The seed ecology of two invasive *Hieracium* (Asteraceae) species** *Australian Journal of Botany* 60: 615-624. http://dx.doi.org/10.1071/BT12058

Booth, T.H. & Williams, K.J. (2012). **Developing biodiverse plantings suitable for changing climatic conditions 1: Underpinning scientific methods.** *Ecological Management & Restoration* 13(3): 267-273. doi: 10.1111/emr.12003

Booth, T.H., Williams, K.J. & Belbin, L. (2012). **Developing biodiverse plantings suitable for changing climatic conditions 2: Using the Atlas of Living Australia.** *Ecological Management & Restoration* 1(3): 274-281. doi: 10.1111/emr.12000

Breed, M.F., Marklund, M.H.K., Ottewell, K.M., Gardner, M.G., Harris, J.B.C. & Lowe, A.J. (2012). **Pollen diversity matters: revealing the neglected effect of pollen diversity on fitness in fragmented landscapes.** *Molecular Ecology* 21: 5955-5968. DOI:10.1111/mec.12056

Carlile, N., Priddel, D., Auld, T.D. & Morrison, D.A. (2012). **Determining the factors affecting seed germination in *Livistona australis* (Arecaceae) for the recovery of fragmented populations.** *Australian Journal of Botany* 60: 575-581. http://dx.doi.org/10.1071/BT12056

Cohn, J.S., Lunt, I.D., Bradstock, R.A. & Koen, T. (2012). **Interactions between dense *Callitris* regeneration and *Eucalyptus* and *Callitris* canopy trees in semi arid woodlands.** *Australian Journal of Botany* 60**:** 549-558. http://dx.doi.org/10.1071/BT11247

Denham, A.J. & Auld, T.D. (2012). **Population Ecology of Waratahs, *Telopea speciosissima***

(Proteaceae): Implications for Management of Fire-prone Habitats. *Proceedings of the Linnean Society of New South Wales* 134: B101-B111. http://escholarship.library.usyd.edu.au/journals/index.php/LIN

Dowling, N. & Jusaitis, M. (2012). **Asymbiotic in vitro germination and seed quality assessment of Australian terrestrial orchids.** *Australian Journal of Botany* 60: 592-601. http://dx.doi.org/10.1071/BT12133

Duff, T.J., Bell, T.L. & York, A. (2013). **Managing multiple species or communities? Considering variation in plant species abundances in response to fire interval, frequency and time since fire in a heathy *Eucalyptus* woodland.** *Forest Ecology and Management* 289: 393-403. http://dx.doi.org/10.1016/j.foreco.2012.10.032

England, J.R., Franks, E.J., Weston, C.J. & Polglase, P.J. (2013). **Early growth of environmental plantings in relation to site and management factors.** *Ecological Management & Restoration* 14(1). doi: 10.1111/emr.12020

Funk, W.C., McKay, J.K., Hohenlohe, P.A. & Allendorf , F.W. (2012). **Harnessing genomics for delineating conservation units.** *Trends in Ecology and Evolution* 27 (9): 489-496. http://dx.doi.org/10.1016/j.tree.2012.05.012

Gibson, N. Yates, C., Byrne, M., Langley, M. & Thavornkanlapachai, R.A (2012). **The importance of recruitment patterns versus reproductive output in the persistence of a short-range endemic shrub ina highly fragmented landscape of south-western Australia.** *Australian Journal of Botany* 60: 643-649. http://dx.doi.org/10.1071/BT12194

Giladi, I., Segoli, M. & Ungar, E.D. (2012). **Shrubs and herbaceous seed flow in a semi-arid landscape: dual functioning of shrubs as trap and barrier.** *Journal of Ecology*. DOI: 10.1111/1365-2745.12019

Goldingay, R.L. (2012). **What Role Does Ecological Research Play in Managing Biodiversity in Protected Areas? Australia's Oldest National Park as a Case Study.** *Proceedings of the Linnean Society of New South Wales* 134: B119-B134. http://escholarship.library.usyd.edu.au/journals/index.php/LIN

Hancock, N. & Hughes, L. (2012). **How far is it to your local? A survey on local provenance use in New South Wales.** *Ecological Management & Restoration* 13(3): 259-266. doi: 10.1111/j.1442-8903.2012.00660.x

Kavanagh, R.P. & Stanton, M.A. (2012). **Koalas use young Eucalyptus plantations in an agricultural landscape on the Liverpool Plains, New South Wales.** *Ecological Management & Restoration* 13(3): 297-305. doi: 10.1111/emr.12005

Research round up (cont.)

Lake, P.S. (2013). **Resistance, Resilience and Restoration.** *Ecological Management & Restoration* 14(1). doi: 10.1111/emr.12016

Lamont, R.W., Stokoe, R.L. & Shapcott, A. (2012). **Ecological genetics of the wind-pollinated, tetraploid, *Allocasuarina emuina* L. Johnson (Casuarinaceae) from southeast Queensland reveals montane refugia for coastal heath during the last interglacial.** *Australian Journal of Botany* 60(8): 718-734. http://dx.doi.org/10.1071/BT12252

Lewis, T., Reif, M. Prendergast, E. & Tran, C. (2012). **The effect of long-term repeated burning and fire exclusion on above- and below-ground Blackbutt (*Eucalyptus pilularis*) forest vegetation assemblages.** *Austral Ecology* 37: 767-778. doi:10.1111/j.1442-9993.2011.02337.x

Lindenmayer, D.B. Likens, G.E., Andersen, A., Bowman, D., Bull, C.M., Burns, E., Dickman, C.R., Hoffmann, A.A., Keith, D.A., Liddell, M.J., Lowe, A.J., Metcalfe, D.J., Phinn, S.R., Russell-Smith, J., Thurgate, N. & Wardle, G.W. (2012). **Value of long-term ecological studies.** *Austral Ecology* 37: 745-757. doi:10.1111/j.1442-9993.2011.02351.x

Lorenzo, P., Pereira, C.S. & Rodríguez-Echeverría, S. (2013). **Differential impact on soil microbes of allelopathic compounds released by the invasive *Acacia dealbata* Link.** Soil Biology & Biochemistry 57: 156-163. http://dx.doi.org/10.1016/j.soilbio.2012.08.018

Lowry, E., Rollinson, E.J., Laybourn, A.J., Scott, T.E., Aiello-Lammens, M.E., Gray, S.M., Mickley, J. & Gurebitch, J. (2012). **Biological invasions: a field synopsis, systematic review, and database of the literature.** *Ecology and Evolution* doi: 10.1002/ece3.431

McDougall, K.L. (2013). **Alpine road colonisation: An update.** *Ecological Management & Restoration* 14(1). doi: 10.1111/emr.12018

Miller, B.P., Walshe, T., Enright, N.J. & Lamont, B.B. (2012). **Grasstree stem analysis reveals insufficient data for inference of fire history.** *Journal of the Royal Society of Western Australia* 95: 95-102.

Moore, J.L. & Runge, M.C. (2012). **Combining Structured Decision Making and Value-of-Information Analyses to Identify Robust Management Strategies.** *Conservation Biology* 26(5): 810-820. DOI: 10.1111/j.1523-1739.2012.01907.x

Oosterzee, P. van (2012). **The integration of biodiversity and climate change: A contextual assessment of the carbon farming initiative.** *Ecological Management & Restoration* 13(3): 238-244. doi: 10.1111/emr.12001

Perkins, I., Diamond, J., SanRoque, G., Raffan, L., Digby, B., Jensen, P. & Hirschfeld, D. (2012). **Eastern Suburbs *Banksia* Scrub: Rescuing an endangered ecological community.** *Ecological Management & Restoration* 13(3): 224-237. doi: 10.1111/emr.12002

Perrett, C., Osunkoya, O.O. & Clark, C. (2012). **Cat's claw creeper vine, *Macfadyena unguis-cati* (Bignoniaceae), invasion impacts: comparative leaf nutrient content and effects on soil physicochemical properties.** *Australian Journal of Botany* 60: 539-548. http://dx.doi.org/10.1071/BT12055

Preece, N.D., Oosterzee, P. van, Lawes, M.J. (2013). Planting methods matter for cost-effective rainforest restoration. Ecological Management & Restoration 14(1). DOI: 10.1111/emr.12017

Schneemann, B. & McElhinny, C. (2012). **Shrubby today but not tomorrow? Structure, composition and regeneration dynamics of direct seeded revegetation.** *Ecological Management & Restoration* 13(3): 282-289. doi: 10.1111/emr.12007

Soliveresa, S., Eldridge, D.J., Hemmings, F. & Maestre, F.T. (2012). **Nurse plant effects on plant species richness in drylands: The role of grazing, rainfall and species specificity.** *Perspectives in Plant Ecology, Evolution and Systematics* 14: 402- 410. http://dx.doi.org/10.1016/j.ppees.2012.09.003

Spooner, P.G. & Morris, M.C. (2012). **Long-term stock grazing management in Travelling Stock Reserves and influence on conservation values.** Ecological Management & Restoration 13(3): 309-311. DOI: 10.1111/j.1442-8903.2012.00658.x

Taylor, D.B.J. & Dhileepan, K. (2012). **Comparative growth and biomass allocation of two varieties of cat's claw creeper, *Dolichandra unguis-cati* (Bignoniaceae) in Australia.** *Australian Journal of Botany* 60: 650-659. http://dx.doi.org/10.1071/BT12117

Taylor, S, Kumar, L & Reid, N (2012). **Impacts of climate change and land-use on the potential distribution of an invasive weed: a case study of *Lantana camara* in Australia.** *Weed Research* 52: 391-401. DOI: 10.1111/j.1365-3180.2012.00930.x

Tng, D.Y.P., Williamson, G.J., Jordan, G.J. & Bowman, D.M.J.S. (2012). **Giant eucalypts - globally unique fire-adapted rain-forest trees?** *New Phytologist* 196: 1001-1014. doi: 10.1111/j.1469-8137.2012.04359.x

Research round up (cont.)

Tozer, M.G. & Keith, D.A. (2012). **Population Dynamics of *Xanthorrhoea resinosa* Pers. Over Two Decades: Implications for Fire Management.** *Proceedings of the Linnean Society of New South Wales* 134:B249-B266. http://escholarship.library.usyd.edu.au/journals/index.php/LIN

Treanor, M.B. (2012). **Natural History in the Royal National Park and the Need to Better Integrate Research into Park Management.** *Proceedings of the Linnean Society of New South Wales* 134: B1-B6. http://escholarship.library.usyd.edu.au/journals/index.php/LIN

Warnock, A.D., Florentine, S.K., Graz, F.P. & Westbrooke, M.E. (2012). **Short-term gain and long-term pain: Lessons learnt from the control of *Lachnagrostis filiformis* (fairy grass) in Victoria, Australia.** *Weed Biology and Management* doi:10.1111/j.1445-6664.2012.00448.x

Williams, N.S.G. (2012). **Vegetation and floristics of four native grassland nature conservation reserves in western Melbourne.** *Proceedings of the Royal Society of Victoria* 124(3): 207-222.

Wilson, B.A., Zdunic, K., Kinloch, J. & Behn, G. (2012). **Use of remote sensing to map occurrence and spread of *Phytophthora cinnamomi* in *Banksia* woodlands on the Gnangara Groundwater System, Western Australia.** *Australian Journal of Botany* 60: 495-505. http://dx.doi.org/10.1071/BT11305

Wyborn, C., Jellinek, S. & Cooke, B. (2012). **Negotiating multiple motivations in the science and practice of ecological restoration.** *Ecological Management & Restoration* 13(3): 249-253. doi: 10.1111/j.1442-8903.2012.00667.x

Contributions to Research Roundup are welcome, and should be sent to Kirsten Cowley at the above email address using an email subject heading “APC Research Roundup” or similar. Their inclusion will be subject to available space.

ANPC Corporate Members

ANPC gratefully acknowledges the support of the following corporate members

Albury Botanic Gardens, NSW

Australian National Botanic Gardens, ACT

Botanic Gardens of Adelaide, SA

Centre for Australian National Biodiversity & Research

Department of Environment and Conservation, WA

Environmental Assessment Branch, Department of Sustainability, Environment, Water, Population and Communities

Murrumbidgee Catchment Management Authority

Royal Botanic Gardens and Domain Trust, NSW

Royal Botanic Gardens Melbourne, VIC

Royal Tasmanian Botanical Gardens, TAS

Sydney Olympic Park Authority, NSW

University of Melbourne, Burnley Campus, VIC

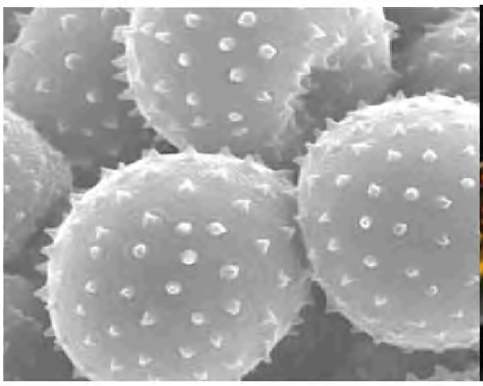


Photo: Dr Louise Morin © CSIRO

Photo: Dr Angus Carnegie © I&I NSW

Myrtle rust – a new threat to Western Australia's biodiversity.

Perth, Bunbury & Albany

20 to 24 May 2013

A one-day course on Myrtle rust recognition, reporting, risk assessment, and management options.

Myrtle rust is a fungal disease of plants that arrived in eastern Australia in 2010. It has already infected over 200 native species in the myrtle family (Myrtaceae) including paperbarks, lillypillies, tea-trees, peppermint, and some eucalypts, among many others. This plant family contains 10% of all Australia's native plant species, is dominant in many Australian ecosystems, and is important in forestry, commercial and home horticulture, and the bush food and medicine industry. Myrtle rust has not yet arrived in Western Australia.

Australian Network for Plant Conservation Inc

GOVERNMENT OF WESTERN AUSTRALIA
Department of Agriculture and Food

The Royal Botanic Gardens & Domain Trust

THE GOVERNMENT OF WESTERN AUSTRALIA
Department of Environment and Conservation

Bjarne K Dahl Trust

Forest Products Commission
WESTERN AUSTRALIA

This course will provide comprehensive information on the disease, and help you to:

- recognise the disease in the field and in cultivation
- identify species and ecological communities at risk
- decide what to monitor before and if the disease arrives
- assess the risks and consequences of spreading the disease, and how to avoid doing so.

PRIOR REGISTRATION ESSENTIAL: download form from www.anpc.asn.au/courses.html

Presented by the Australian Network for Plant Conservation Inc. (ANPC) in association with the Royal Botanic Gardens & Domain Trust (Sydney) and supported by the Bjarne K Dahl Trust. These events sponsored by the WA Department of Environment & Conservation, WA Department of Agriculture & Food and the Forest Products Commission.